

IMPROVED BULK MATERIAL CONTAINER ASSEMBLY

Field of the Invention

5 The invention relates to the movement and control of shipping containers. In particular, the invention relates to the movement and control of containers adapted to transport of bulk materials.

Background

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A particular type of container is used for bulk material such as grain, aggregate, coal etc. These containers are used for ship to shore cranes, mobile cranes, harbour cranes and container lifting trucks. Specially adapted apparatus is used for dealing with bulk material containers and is generally referred to as a bulk material handling assembly
15 which comprises a head frame for engaging the crane through a sheave and engagement devices for engaging the container. A motor is also used for rotating the container from a vertical position to an inverted position for unloading bulk material.

Bulk material containers vary from conventional containers in a number of different
20 ways. One such way is the thickness and structural stability of the walls. A conventional container is used for carrying cargo which does not apply a load to the walls but merely sits on the base. However, bulk material containers apply a “hydrostatic” load against the walls leading to the need for reinforcement of the walls. This generally makes the container heavier and more expensive to manufacture. Whilst

not good practice, conventional containers are often modified by removing the top and sealing the edges so as to be used to transport bulk material. Consequently, the walls are much thinner and less capable of supporting the bulk material, particularly during unloading. To this end, as the container is rotated the bulk material will eventually bear
 5 directly down on the wall after a 90° rotation applying significant loads to the container wall for which it was not designed. Consequently, container walls may buckle and deform either permanently damaging the container or leading to a catastrophic failure and dumping of the bulk material across the wharf.

10 Bulk material handling assemblies, because of the need to rotate the container, are generally expensive compared to spreaders used for conventional containers. It is therefore an expensive exercise to have separate assemblies corresponding to the wide range of bulk material containers used, which may vary in length from conventional 20-foot to conventional 40-foot and even 45-foot containers. The consequential
 15 infrastructure cost to a port that may have to handle containers of varying lengths is therefore considerable.

Another handling problem associated with bulk material is the tendency for the material to shift, either during transport or during unloading. Whilst ideally the bulk material
 20 will be centred about a centre line passing through the lifting cables and thus be aligned, in practice and particularly during the rotational unloading stage the material will shift and so apply an eccentric load to the assembly. The redistribution of load will then tilt the head frame so as to be away from the vertical. If occurring during the unloading

stage the added load that the lower rotational engagement must bear maybe considerable leading to deformation and permanent damage to the bulk material handling assembly.

Further still, whilst the handling of conventional containers is a relatively clean exercise as the containers are sealed; this is not the case for bulk material. Bulk material containers during unloading will have one side open and given the variable particle size of the material, during the unloading stage a considerable volume of air borne dust will result. Depending on the nature of the bulk material this may cause both environmental and health issues for operators and others located on the wharf or ship.

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Summary of Invention

In a first aspect the invention provides a bulk material handling assembly comprising: a head frame having a pair of container engaging devices for engaging a container at opposed ends of said head frame; said container engaging devices rotationally mounted to opposed ends of said head frame and arranged to selectively rotate said container; wherein said head frame includes a pair of selectively extendable arms arranged to extend said opposed ends.

20 By providing extendable arms on the bulk material handling assembly ("BMHA") according to the present invention, a single assembly can be used to accommodate containers of varying lengths and so reduce the costs of infrastructure within the port. In one embodiment, the arms may be telescopic so as to be in sliding engagement with

the remainder of the head frame. Alternatively, the arms may be in a rack and pinion type engagement. Further still the extendable arms may be geared such that rotation of a single gear drives both the extendable arms with each arm acting as a rack engaged with the single pinion/gear. This single gear may be in communication with a single
5 actuator such that extension or retraction of the extendable arms is achieved on operation of the single actuator.

In a second aspect the invention provides a bulk material handling assembly comprising:
a head frame having a pair of container engaging devices for engaging a container at
10 opposed ends of said head frame; said container engaging devices rotationally mounted to opposed ends of said head frame and arranged to selectively rotate said container;
said head frame including a sheave assembly for engaging lifting cables; said sheave assembly including a sheave pivotally connected to head frame and at least one actuator connected to both the head frame and sheave; wherein on application of an eccentric
15 load to the bulk material handling assembly, said sheave is arranged to pivot relative to the head frame through activation of said at least one actuator to bring the head frame into a horizontal position.

By providing a sheave which can pivot about a central point, the centre line
20 corresponding to the lifting cables can be offset from the centre line of the head frame so as to align with the eccentrically placed centre of gravity of the container. This will then bring the head frame into a horizontal position and so leveling the head frame despite the repositioned bulk material.

A control system may be combined with the BMHA so that on activating a sensor which then sends a signal to the control system that the head frame is no longer horizontal, the control system may then activate the actuator to pivot the sheave and so
 5 bring the head frame back to the horizontal position. A constant interrogation by the sensor may then have a closed feedback loop through the control system leading to the head frame remaining horizontal throughout the unloading cycle.

The sheave may be pivoted through a single actuator extending or retracting.
 10 Alternatively, there may be two actuators working together so that one may retract and the other extend in order to achieve the pivot. In a further embodiment, the actuator may be a rotational actuator positioned about the pivot to achieve a relative pivot of the sheave and head frame.

15 In a third aspect the invention provides a method for leveling a head frame of a bulk material handling assembly, the method comprising the steps of: engaging a container; eccentrically loading the bulk material handling assembly, and so; inclining the head frame; pivoting a sheave of said head frame, and so aligning lifting cables connected with said sheave with the eccentrically placed centre of gravity of said container, and so; bringing the head frame back to
 20 a horizontal position.

By having the beams in a position to support the container should bulk material be applied a “hydrostatic” load to the container wall during rotation or in fact at any time during engagement with the BMHA, the beams may either directly bear load if in

contact or if placed proximate to the walls prevent excessive buckling of the walls as the walls tend to buckle out. In any event, the structural integrity of the container is maintained during handling and particularly during the unloading cycle.

- 5 In a fourth aspect the invention provides a bulk material handling assembly comprising:
a head frame having a pair of container engaging devices for engaging a container at
opposed ends of said head frame; said container engaging devices rotationally mounted
to opposed ends of said head frame and arranged to selectively rotate said container; a
pair of beams mounted parallel to a longitudinal axis of said head frame; each of said
10 beams attached to the container engaging devices on either side of the head frame;
wherein said beams are placed so as to support the container during rotation of the
container.

- To avoid environmental and health concerns, by having nozzles directed to the
15 container either during handling or during unloading, the water spray will suppress the
air borne dust and so containing the material.

- In a further embodiment, the water nozzles may further include water nozzles in cavities
around the BMHA to wash out dust which would otherwise be trapped. Thus, whilst
20 the initial water nozzles are used for unloading and preventing the spread of air borne
dust the cavity nozzles may be used to maintain the cleanliness of the BMHA over time.

In a fifth aspect the invention provides a bulk material handling assembly comprising: a head frame having a pair of container engaging devices for engaging a container at opposed ends of said head frame; said container engaging devices rotationally mounted to opposed ends of said head frame and arranged to selectively rotate said container; a
5 plurality of water nozzles mounted to said head frame; wherein said nozzles are directed downwards and arranged to direct water spray onto said container during unloading of the bulk material so as to suppress airborne dust.

In a sixth aspect the invention provides a locating frame having at least one bay for receiving at
10 least one container, said frame including a plurality of locating brackets arranged about said at least one bay to position a container within the bay, corresponding to a required position for engagement by a bulk material handling assembly.

Brief Description of Drawings

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It will be convenient to further describe the present invention with respect to the accompanying drawings that illustrate possible arrangements of the invention. Other arrangements of the invention are possible and consequently, the particularity of the accompanying drawings is not to be understood as superseding the generality of the
20 preceding description of the invention.

Figures 1A is an elevation view of a bulk material handling assembly according to one embodiment of the present invention;

Figure 1B is a sequential view of the unloading of a bulk material handling using a container support system according to one embodiment of the present invention;

- 5 Figures 2A and 2B are elevation views of a bulk material handling assembly according to a further embodiment of the present invention;

Figures 3A, 3B and 3C are elevation views of a bulk material handling assembly according to a further embodiment of the present invention;

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Figure 4 is an isometric view a bulk material container assembly according to a further embodiment of the present invention;

- Figures 5A to 5D are isometric views of a twin bulk material handling assembly
15 according to a further embodiment of the present invention;

Figures 6A to 6C are elevation views of the twin bulk material handling assembly of Figure 5A, and;

- 20 Figures 7A to 7C are isometric views of the progressive engagement of a container according to a further embodiment of the present invention.

Detailed Description

Figure 1A shows a bulk material handling assembly 5 having a head frame 10 and container engaging devices 15 arranged to engage a container 30. In this case the container 30 is a bulk material container used to transport particulate matter such as aggregate, grain, coal or other loose material. The container engaging devices 15 are connected to the head frame 10 through a rotational engagement 25 which includes a motor for rotating the engagement devices 15 and the container 30. The assembly 5 further includes a support system including support beams 35 placed parallel to the longitudinal axis of the head frame 10 and mounted between the engagement devices 15. The beams 35 act to support the container as it is handled and rotated. In particular, the beams 35 are arranged to be in contact with, or proximate to, the wall of the container 30. The support beams are intended to prevent buckling of the container wall 30 as the bulk material within the container shifts during rotation of the container. Bulk material containers are characterized by having a thicker wall to accommodate the shifting of material during unloading. However, increasingly conventional containers are modified to carry bulk materials. A specific drawback of this trend is that conventional containers may have a much thinner wall than a bulk material container. Bulk material containers must act to both encompass material and also resist the applied loads of this material during transport. Accordingly, the invention seeks to prevent failure of the container or prevent damage to the port infrastructure should a conventional container buckle during the rotation process. By providing a beam 35 in close proximity, or in contact with, the wall of the container 30, the beam will provide further support to the container and consequently prevent or mitigate the risk of container wall buckling.

Figure 1B shows a sequential view of the rotation process using the support system according to one embodiment of the present invention. Here, a bulk material container assembly 40 comprises a head frame 45 rotationally engaged with container engagement devices 50 for engaging a container 60 used to transport a bulk material 65.

5 In this embodiment, a support system comprising beams 55 are brought into contact with, or proximate to 62, the walls of the container 60. On rotation 70 of the container 60, the bulk material 65 will begin to shift applying significant loads to the lower most wall of the container. The lower most beam 55 being in contact with the container 60

10 immediately has loads distributed to it and so provides support to the container wall. In another embodiment, the beam 55 may be proximate to the container and so not in direct contact. In this case, the beam will only bear load distributed from the container should the container wall begin to buckle, by placing the beam at a distance from the container wall such that on buckling of the wall the beam will receive load. The system

15 may be designed such that the distance is less than a catastrophic buckling event but far enough away so as to prevent interference between engagement of the container and the beams itself. A bulk material handling assembly may be designed for an ultimate safety condition by having the beams in contact with the container or it may be designed as a precaution by having the beams proximate to but not in contact with the container and

20 so only contact the container should the container walls begin to buckle. In this latter case, the advantage of having the beams away from the container provide convenience for the operator of the assembly to engage the container and reduce the risk of the beams becoming into contact with the container during loading which may cause damage. In a still further embodiment, the beams may be selectively moveable. Said

beams may be moveable in a vertical direction which the container is in a normal position. The advantage of the beams being moveable in a vertical direction allows the beams to align with a centre of gravity of the container containing the bulk material.

- 5 In a further embodiment, the beams may be moveable inwards such that during engagement of the container the beams are moved outwards so as to provide clearance for the engagement process. Following engagement with the container, the beams may be selectively moved inwards to go from a fully outward position to be moved inwards so as to contact the container. In this further embodiment, the advantages of having a
- 10 safe condition are achieved as are the advantages of having the beams away from the container during the engagement process.

Returning to Figure 1B, as rotation continues bulk material 75 will begin to pour from the container until a full rotation of the container finally empties the container.

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- Figures 2A and 2B show a further embodiment of the present invention. Here, a bulk material handling assembly 85 includes a head frame 90 with a pair of container engagement devices 100 arranged to engage a container 110. The container engagement devices 100 are connected to the head frame 90 through a rotational
- 20 engagement 95 for rotating the container 110. In this embodiment, the head frame 90 includes extendable arms 105, in this case telescopically extended arms which act to selectively lengthen or shorten distance between the container engagement devices 100. Figure 2A shows a retracted position whereby the bulk material container assembly 85 has the extendable arms 105 retracted so as to engage a 20-foot container 110. On

extending 120 the arms 105 as shown in Figure 2B, a 40-foot container 115 can now be engaged by the bulk material container assembly 85. It will be appreciated that the extendable arms may be extendable to discreet lengths so as to accommodate known container types such as 20-foot, 40-foot and 45-foot containers. Alternatively, the
5 extendable arms may be infinitely extendable between a fully retracted and fully extended length so as to accommodate containers or other intermodal devices of non-standard lengths.

In a further embodiment, Figure 3A to 3C shows a bulk handling container assembly
10 125 arranged to accommodate shifting bulk material or eccentrically loaded containers. The assembly 125 includes a head frame 130 with container engagement devices 135 mounted to a rotational engagement 140. In the present invention, a sheave assembly 145 is also included.

15 The sheave assembly 145 includes a sheave 150 pivotally mounted 152 to the head frame 130. The sheave 150 is capable of pivoting within the vertical plane of the head frame 130 from one extreme position 155 to another extreme position 160. In order to effect this pivotal movement, the invention provides for at least one actuator, in this case two actuators 165, 170 which are mounted between the head frame 130 and the
20 sheave 150.

Figures 3B and 3C shows two extreme conditions whereby pivoting of the sheave is required. In Figure 3B, the assembly 125 has engaged the container 175. The bulk material within the container 175 has shifted so as to place the centre of gravity 180

towards the right hand side of the container. If the sheave 150 were to stay in a central position, the assembly 125 would rotate about the upper portion 154 of the sheave so as to place the centre of gravity of the container in alignment with the cables connecting the assembly 125 to the crane. The present invention, by having a pivotal sheave, is
5 able to shift the position of the sheave such that it places the centre of gravity 180 in line with the cables 185 whilst maintaining a horizontal position of the head frame. It achieves this by retracting one actuator 170 and extending the complimentary actuator 165 so as to pivot the sheave 160. Thus, the centre of gravity is still in line with the cable but by shortening the distance between the sheave and the head frame, the head
10 frame maintains the horizontal position.

Figure 3C shows an alternative position whereby the container 190 engaged by the assembly 125 has the material shifted to the left, placing the centre of gravity 195 on the opposed side of the assembly. By now retracting the left side actuator 165 and
15 extending the right side actuator 170, the sheave 155 is pivoted to the left and so keeping the head frame 130 horizontal whilst maintaining the centre of gravity 195 in line with cables 200.

It will be appreciated that an operator may visually, or using sensors, control the
20 actuators 165, 170 in order to place the head frame 130 in a horizontal position. This is particularly important during the unloading of the bulk material as during the rotational cycle in order to unload the bulk material, the bulk material will shift and thus may cause an eccentric loading. The operator can then adjust the actuators 165, 170 so as to maintain the head frame in horizontal position during the unloading cycle.

Alternatively, a feedback loop with an automatic control system (not shown) that is connected to sensors such as accelerometers, inclinometers or load cells which will detect the eccentricity of the load. This may occur at the time of engaging the container
5 or during the unloading cycle. The information is sent to the control system which consequently controls the at least one actuator to maintain a horizontal position of the head frame without intervention from the operator.

Figure 4 shows a further embodiment of the present invention whereby a bulk material
10 handling assembly 205 having a head frame 210 and container engagement devices 215 mounted to the head frame 210 through a rotational engagement 220. In this embodiment, the head frame 210 includes dust suppressant nozzles 225 directed to provide a mist or spray onto the container so as to prevent dust from the bulk material escaping the container. This is particularly important during the unloading cycle
15 whereby shifting of the bulk material out of the container will lead to fine dust from the bulk material dissipating causing environmental and health hazards.

Further, to prevent the build up of air borne dust from the unloading of bulk material within cavities of the assembly 205, suppressant sprays (not shown) within cavities of
20 the assembly 205 may periodically operate to remove said dust.

The dust suppressant nozzles 225 and cavity nozzles (not shown) may be connected to a water supply on the head frame 210 or connected through a water supply in parallel with lifting cables and the electrical supply provided to the assembly 205.

It will be appreciated that the aspects shown in the figures may be used separately or in various combinations.

5 Figures 5A to 5D and Figures 6A to 6C show a bulk material handling assembly, in this case having two bays to engage two containers. For convenience, this will be referred to as a twin bulk material handling assembly 235 according to a further embodiment of the present invention. The assembly 235 includes a head frame 240 engaged with container engaging devices 265, 270, 275, 280 arranged to engage two containers in separate bays
10 245, 250. The containers are arranged longitudinally and separated by block 260 which permits rotation of each of the containers separately as shown in Figures 5B to 5D.

The twin bulk material handling assembly 235 is capable of engaging either one or two containers at the same time. Figure 6A shows the two bays 245, 250 empty with Figure
15 6D showing the first bay 245 engaged with a container 295 and Figure 6C showing both bays 245, 250 engaged with containers 295, 300.

It will be appreciated that the support system of Figures 1A and 1B may be used with the twin bulk material handling assembly of Figures 5A to 5D. Particularly where the
20 movement of the maximum number of containers is required by the operator, the chance for a conventional container modified act as bulk container may be missed.

Similarly, the extension capability shown in Figures 2A and 2B are equally applicable here, whereby modifying the assembly to accommodate different sized containers will further optimize the rate of container handling.

- 5 The sheave assembly of Figures 3A to 3C is also applicable to the twin bulk material handling assembly. Further, in the case of the twin bulk material handling assembly having the extension capability demonstrated in Figures 2A and 2B, by using the sheave assembly of Figure 3A to 3C, the ability to handle two containers of different sizes may also become possible, by shifting the position of the sheaves to accommodate the center
10 of gravity of the eccentrically loaded assembly.

Figures 7A to 7C show a container positioning frame 305 used to increase the speed of engagement of containers 325, 330 by a twin bulk material handling assembly 335. It does this by locating the containers 325, 330 precisely within the frame 305 through
15 locating corner brackets 310. The locating brackets may include flared upper ridges so as to centre the container if marginally misaligned and so facilitating placement by a crane or forklift.

As shown in Figure 7B, once placed in the frame 305, the containers are precisely
20 spaced on either side of a clearance 320 which accommodates the centre portion of the twin bulk material handling assembly 335. The twin bulk material handling assembly 335 can then simply lower itself onto the containers and immediately engage the containers ready for handling as shown in Figure 7C.

Claims

1. A bulk material handling assembly comprising

a head frame having a pair of container engaging devices for engaging a
5 container at opposed ends of said head frame;

said container engaging devices rotationally mounted to opposed ends of said

head frame and arranged to selectively rotate said container;

wherein said head frame includes a pair of selectively extendable arms arranged
to extend said opposed ends.
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2. The bulk material handling assembly according to claim 1, wherein said

extendable arms are telescopic arms.
3. The bulk material handling assembly according to claim 1 or 2, wherein at a
15 fully retracted position of said extendable arms the assembly is arranged to

engage a 20 foot container.
4. The bulk material handling assembly according to any one of claims 1 to 3,

wherein at a fully extended position of said extendable arms the assembly is
20 arranged to engage a 40 foot container.

5. A bulk material handling assembly comprising
- a head frame having a pair of container engaging devices for engaging a container at opposed ends of said head frame;
- said container engaging devices rotationally mounted to opposed ends of said head frame and arranged to selectively rotate said container;
- said head frame including a sheave assembly for engaging lifting cables;
- said sheave assembly including a sheave pivotally connected to head frame and at least one actuator connected to both the head frame and sheave;
- wherein on application of an eccentric load to the bulk material handling assembly, said sheave is arranged to pivot relative to the head frame through activation of said at least one actuator to bring the head frame into a horizontal position.
6. The bulk material handling assembly according to claim 5, further including sensors arranged to detect and signal whether the head frame is horizontal, and a control system arranged to receive the signal and to activate the at least one actuator to bring the head frame to a horizontal position.
7. The bulk material handling assembly according to claim 5 or 6, wherein there are two actuators placed on opposed sides of said sheave and arranged to pivot said sheave through extending one actuator and retracting the other.

8. A method for leveling a head frame of a bulk material handling assembly, the method comprising the steps of:
 - engaging a container;
 - eccentrically loading the bulk material handling assembly, and so;
 - 5 inclining the head frame;
 - pivoting a sheave of said head frame, and so aligning lifting cables connected with said sheave with the eccentrically placed centre of gravity of said container, and so;
 - bringing the head frame back to a horizontal position.
- 10 9. The method of claim 8 further including the steps, after the engaging step, of:
 - rotating the container to unload the bulk material, and so;
 - shifting the bulk material so as to eccentrically place the centre of gravity of the container.
- 15 10. A bulk material handling assembly comprising
 - a head frame having a pair of container engaging devices for engaging a container at opposed ends of said head frame;
 - said container engaging devices rotationally mounted to opposed ends of said head frame and arranged to selectively rotate said container;
 - 20 a pair of beams mounted parallel to a longitudinal axis of said head frame;

each of said beams attached to the container engaging devices on either side of the head frame;

wherein said beams are placed so as to support the container during rotation of the container.

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11. The bulk material handling assembly, wherein the beams are arranged to be in contact with the container.

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12. The bulk material handling assembly, wherein the beams are arranged to be proximate to the container.

13. The bulk material handling assembly, wherein the beams are selectively movable relative to the container.

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14. A bulk material handling assembly comprising

a head frame having a pair of container engaging devices for engaging a container at opposed ends of said head frame;

said container engaging devices rotationally mounted to opposed ends of said head frame and arranged to selectively rotate said container;

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a plurality of water nozzles mounted to said head frame;

wherein said nozzles are directed downwards and arranged to direct water spray onto said container during unloading of the bulk material so as to suppress airborne dust.

- 5 15. A locating frame having at least one bay for receiving at least one container, said frame including a plurality of locating brackets arranged about said at least one bay to position a container within the bay, corresponding to a required position for engagement by a bulk material handling assembly.

- 10 16. The locating frame according to claim 15, further including a second bay for receiving a second container, the first and second bays being in spaced relation corresponding to a spacing for engagement by a twin bulk material handling assembly.