

[54] BULK MATERIAL UNLOADER

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[58] Field of Search 198/36, 75, 82, 94, 91; 214/10, 14, 15 R, 15 D, 15 E; 37/189

[56] References Cited

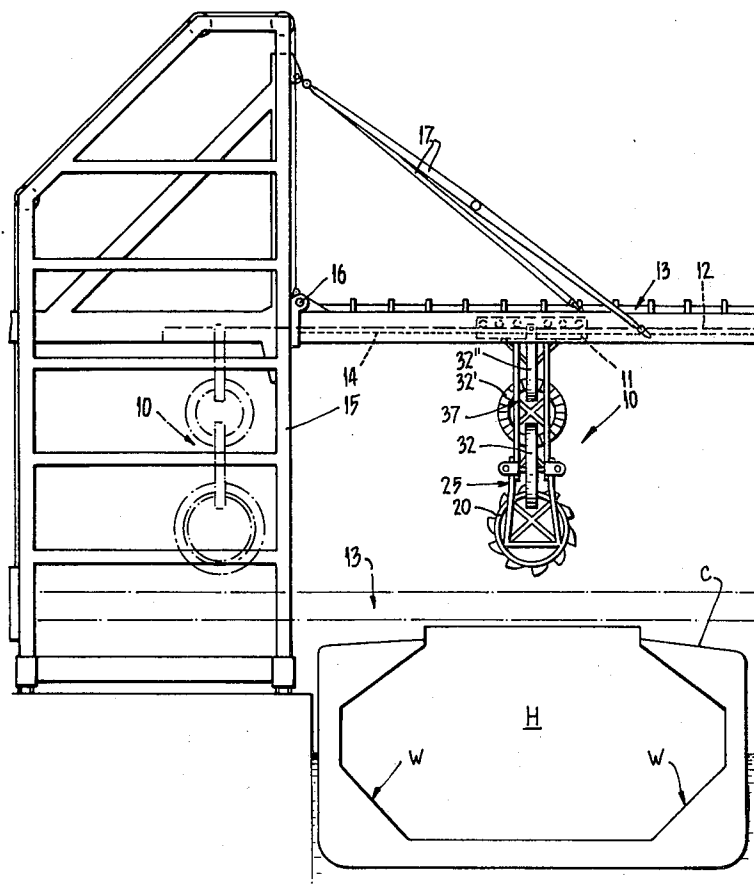
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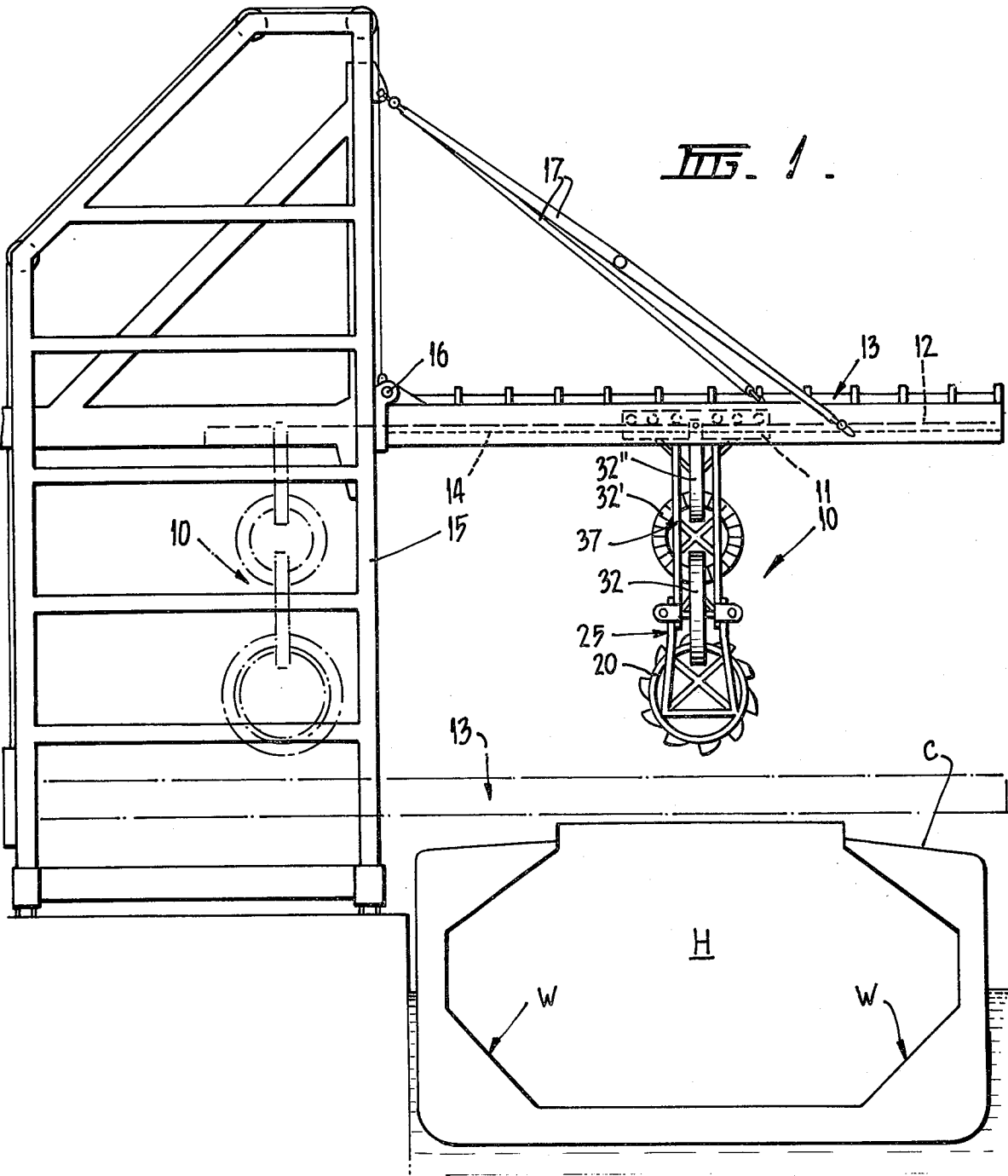
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Attorney, Agent, or Firm—Cushman, Darby & Cushman

[57] ABSTRACT

This specification discloses a bulk material unloader of the type suitable for unloading materials from deep holds of bulk material carriers. In one preferred form of the invention, the unloader comprises a plurality of elevated wheels of open channel cross section divided into a plurality of material retaining pockets, said wheels being linked together in chain fashion whereby the contents of one wheel is directly discharged from each pocket into the wheel with which the first mentioned wheel is linked. The wheels are fed by a rotary digging bucket wheel and are supported by a frame which is pivotally mounted on a supporting bridge or the like. The digging bucket wheel is mounted on a frame which is pivotally mounted at the lower end of the elevator wheel frame and the two frames are pivotable about mutual perpendicular axes. In another form, the elevator wheels are arranged adjacent to each other with their planes of rotation substantially parallel and in overlapping relationship. Gravity transfer chutes extend between the adjacent wheels so that the material being elevated is discharged from one wheel to the other. Again, a digging bucket wheel feeds the lowermost wheel of the elevator.

10 Claims, 5 Drawing Figures





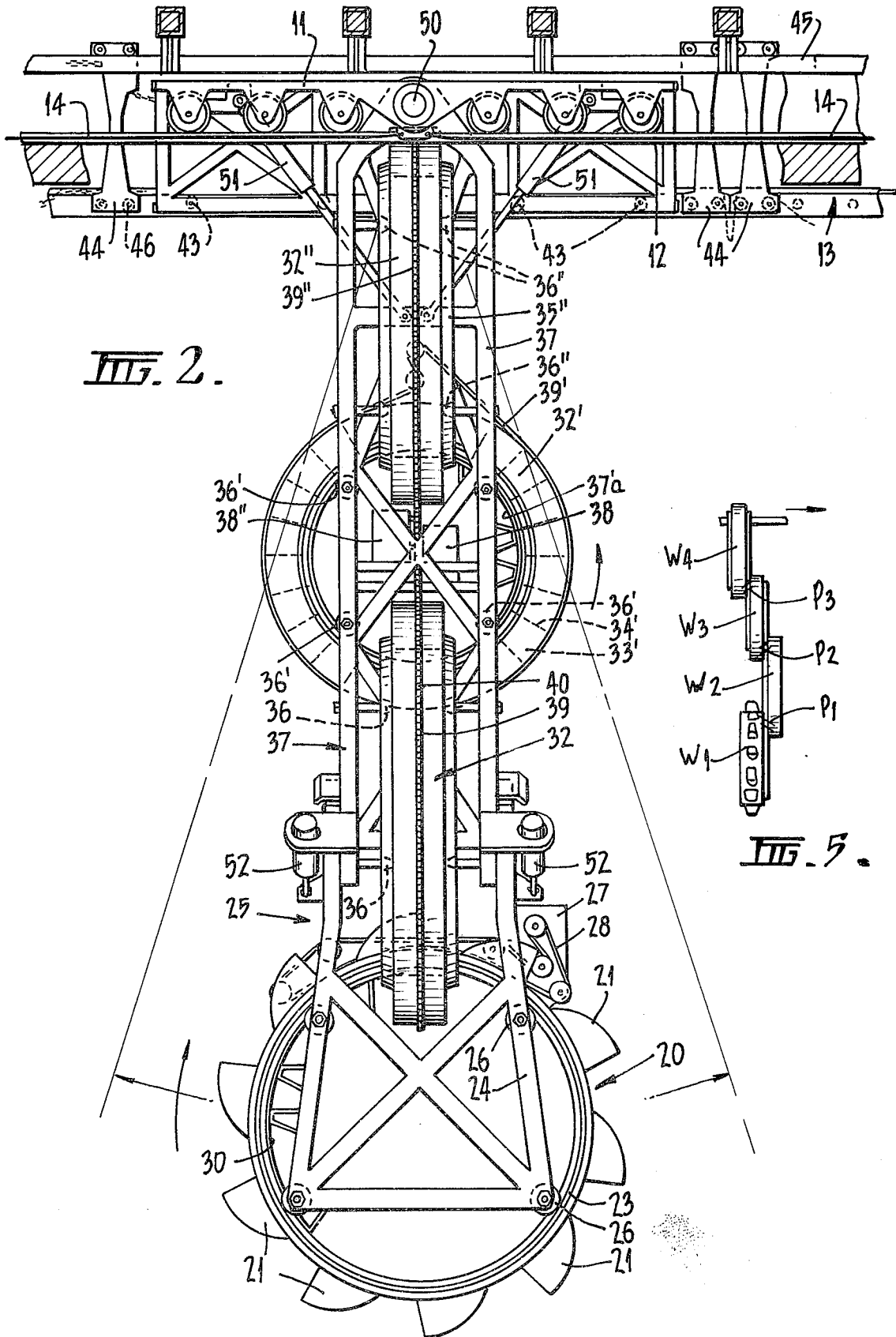


FIG. 2.

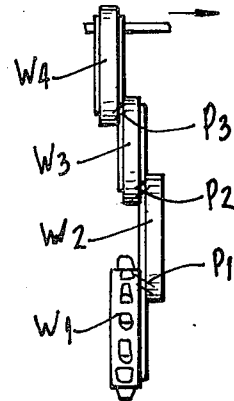
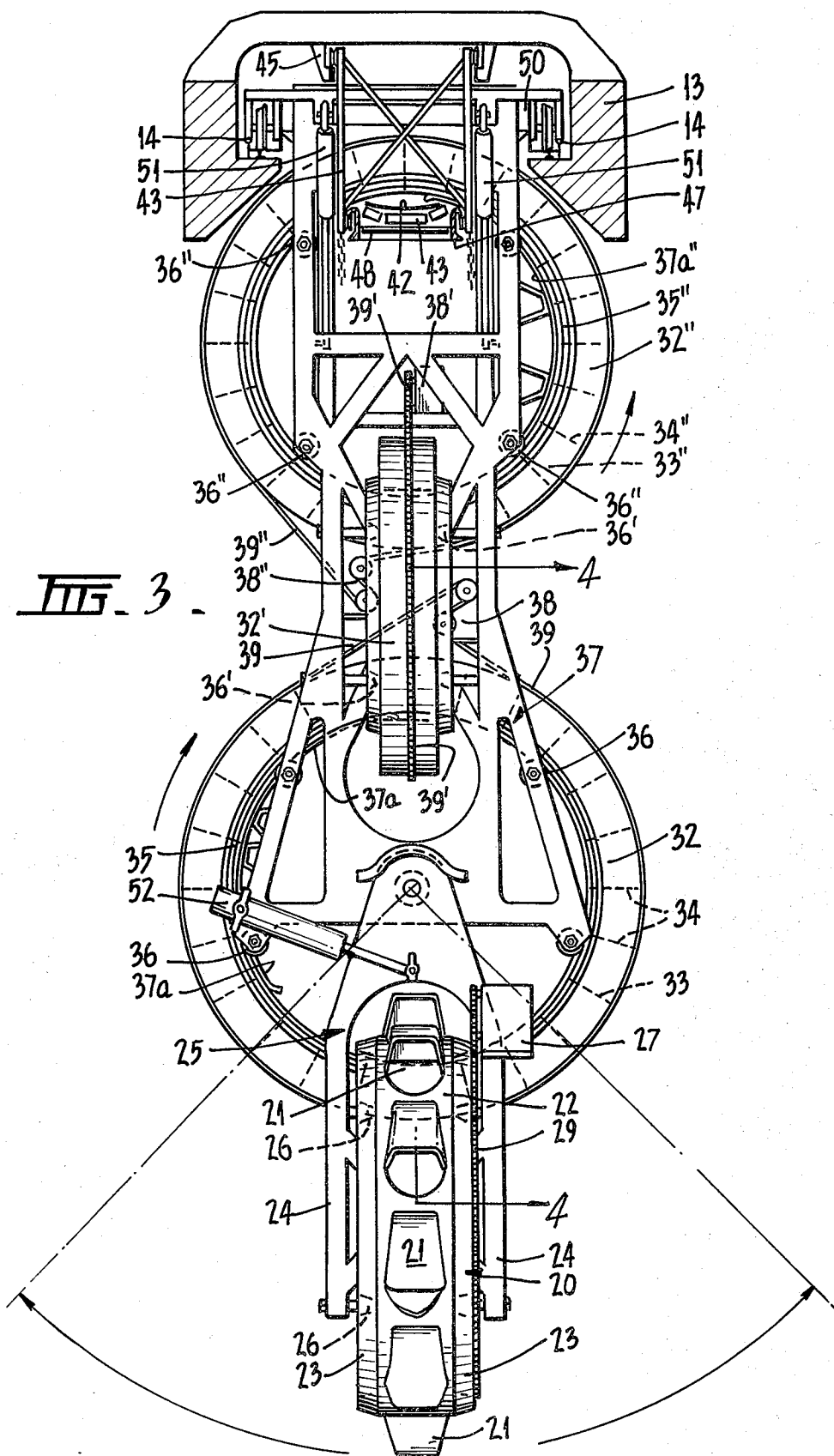
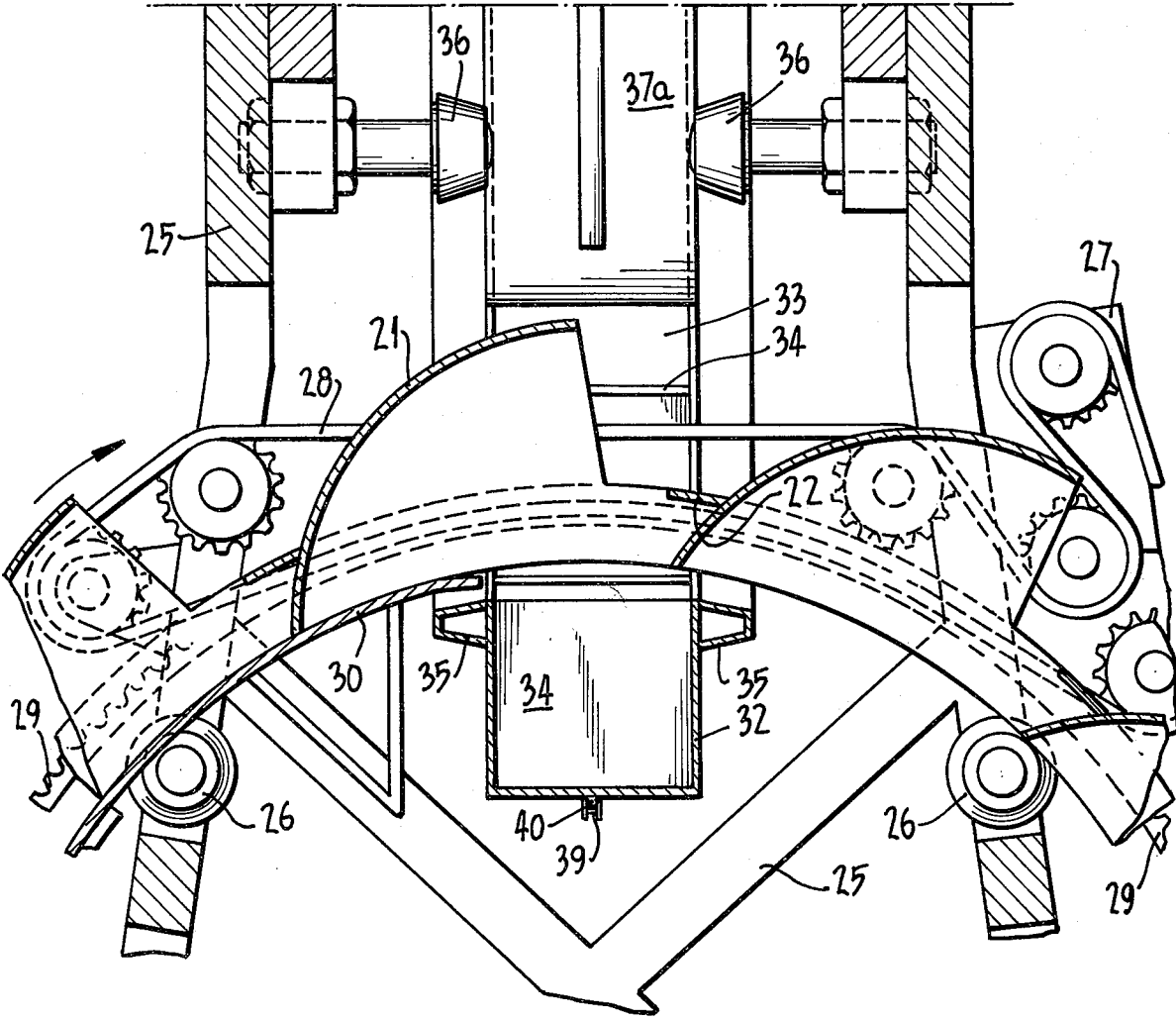
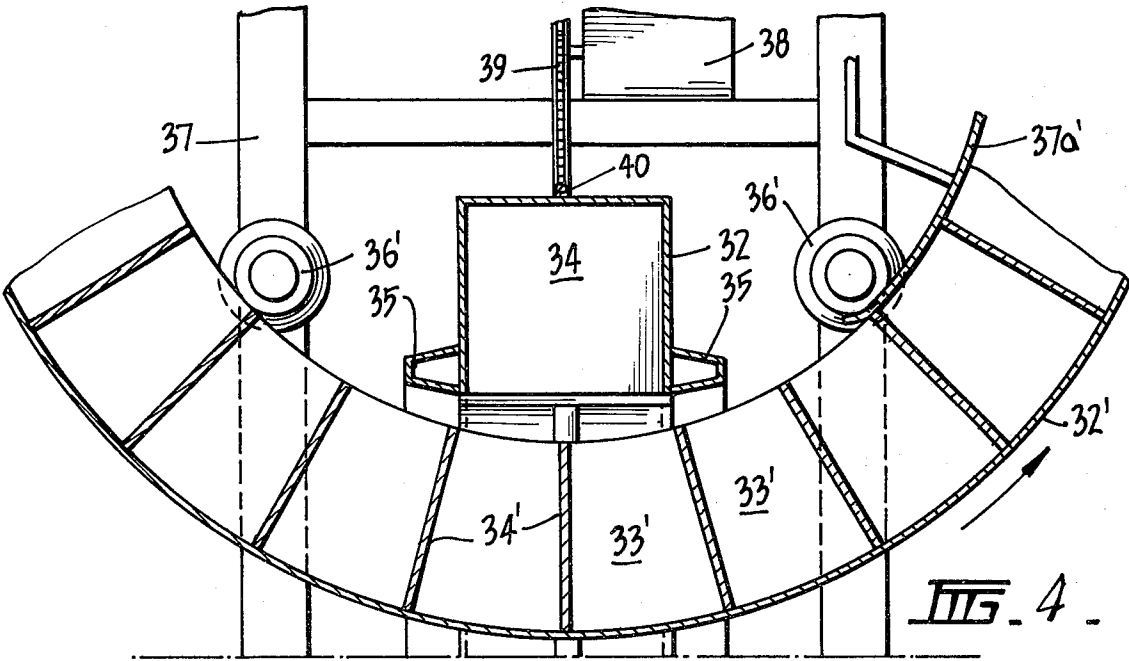


FIG. 5.





BULK MATERIAL UNLOADER

This invention relates to bulk material unloaders, such as those used for unloading materials such as ores from deep holds of bulk material carriers.

The rates at which the heavier ore cargoes can be loaded into ships irrespective of their tonnage has risen steadily particularly over the last decade. 6,000 tons per hour is quite normal, 10,000 tons per hour is by no means impossible, and as an example, Vizagapatnam in India intends to expand its port and associated facilities to ultimately handle a loading rate of 16,000 tons per hour.

Whilst loading rates have developed, the unloading has not kept pace. The biggest clam-shell unloader operates in the vicinity of only 3,000 tons per hour. Such a rate is a free digging rate relative to a short horizontal and vertical travel of the grab bucket. The larger the ship to be worked and the greater the vertical and horizontal travel, the more the rate drops falling below 2,000 tons per hour when a vessel over 100,000 dwt is being worked.

Today the best discharging rate available to any ship carrying iron ore is in the order of 5,500 tons per hour which allows for the use of three ore bridges or clam-shell grab bucket units. This is a net unloading rate which would drop considerably when considering the gross unloading rate.

The main object of this invention is to provide a material unloader which is capable of unloading at a faster rate than conventional equipment and which although heavy in construction is not prone to servicing or breakdown difficulties as the prior art unloaders.

In one aspect the invention provides a bulk material unloader including means for digging the material from a bulk supply, said digging means being arranged to discharge the collected said material into an elevator means for raising the material to an elevated position with respect to the digging means, characterised in that said elevator means comprises a plurality of elevator wheels of sized open channel cross section divided into a plurality of material retaining pockets, each wheel being rotatably mounted on a supporting frame in ascending relationship with respect to each other and, each wheel being arranged to discharge the contents of its pockets by gravity into the pockets of the next most elevated wheel with the lowermost wheel receiving material from said collecting means, driving means for rotating said wheels at a substantially common speed and means for collecting the material discharged from the uppermost elevator wheel.

The wheel-like elevators are preferably circular but may have any open configuration having a generally central axis of rotation.

Each elevator preferably is of rigid construction comprising a flat rim and radial side walls defining an open annular channel, said channel being divided into pockets, such as by circumferentially spaced radial or inclined transverse dividing walls.

The lowermost elevator in the 'chain' is fed with material in any suitable manner such as by one or more digging bucket wheels arranged on a frame supporting the chain and discharging into the lower elevator. Preferably a single bucket wheel is arranged in interlocking relationship with the lower elevator as described in more detail later.

In another aspect of the invention there is provided a bulk material unloader comprising means for digging the material from the supply and for discharging same into an elevator means, said collecting means and said elevator means being supported on separate frames, characterized in that said collecting means frame is pivotally mounted on said elevator frame and the collecting means is pivotable transversely of the elevator frame.

A preferred form of the invention will now be described with reference to the accompanying drawings in which:

FIG. 1 is a side elevation of an ore bridge supporting an unloader embodying the invention over a bulk ore carrier;

FIG. 2 is a side elevation of the unloader and the carriage wheel supports the unloader on the ore bridge;

FIG. 3 is a front-elevation taken along the line 3—3 in FIG. 2;

FIG. 4 is a fragmentary sectional elevation along line 4—4 in FIG. 3 showing the relationship between the first and second elevator wheels and between the digger wheel and the first elevator wheel respectively, and

FIG. 5 is a schematic representation of an alternative wheel arrangement.

In the arrangement shown in FIG. 1 the bulk material unloader 10 is mounted on a carriage 11 supported on rail 12 forming part of a pivoted ore bridge 13. A winch wire 14 is provided to move the carriage along the bridge 13. The boom 13 can be raised and lowered with respect of a tower 15 on which the bridge 13 is mounted to facilitate movement of the unloader 10 into and out of the hold H of an ore carrier C. For berthing of the carrier C, the bridge 13 can be raised about pivot 16 by cable /pulley system 17.

Referring more particularly to FIGS. 2 and 3, the unloader 10 will be seen to comprise a digger wheel and three elevator wheels linked together in chain fashion.

The digger wheel 20 is basically a bucket wheel comprising a suitable number of open-top buckets 21 welded into a suitably apertured rim 22 and formed into a rigid assembly by annular box frame sections 23 welded to the edges rim 22 and to the sides of the buckets 21 (FIG. 3).

The bucket wheel 20 is rotatably supported between the reinforced legs 24 of a yoke frame 25 by means of two sets of four cantilevered taper bearings 26 engaging the box frame sections 23 at either side of the wheel. The use of taper bearings 26 should obviate the need for flanges on sections 23 which would be required if plain rollers were used.

The wheel 20 is driven by an hydraulic or electric motor 27 through a chain 28 supported by sprockets as shown in FIG. 5 and in semi-peripheral driving engagement with a toothed annulus 29 secured to one of the box sections 23. For the purpose of illustration, the speed of the wheel 20 may be of the order of 5 r.p.m.

The legs 24 of the yoke 25 also support a material constraining plate 30 arranged inside the wheel 20 with a slight clearance from the rim 23 and the open tops of the buckets 21. The plate 30 extends from about 45° from the bottom of the wheel 20 to a position just short of the top of the wheel 20 (FIG. 5). The plate 30 acts to constrain the material collected by the buckets 21 in the buckets 21 as it is elevated to the top of the wheel 20.

The buckets 21 discharge their contents into the first elevator wheel 32 as they pass the top edge of the constraining plate 30. The wheel 32 comprises a rectangular U-section annulus divided into a series of material confining pockets 33 by radial plates 34. The elevator wheel 32 has box frame sections 35 similar to sections 23 welded to the sides thereof and the wheel 32 is similarly rotatably supported by four cantilevered taper bearings 36, secured to a further yoke frame 37, at either side of the wheel 32.

A constraining plate 37a similar to plate 30 is supported by the frame 37 with a small clearance from the wheel 32 to constrain the material transferred into the pockets 33 until it is discharged into the next elevator wheel. The volume of each pocket 33 is such that the material transferred from the buckets only partly fills same.

The wheel 32 is rotated by a motor 38 driving a chain 39 peripherally engaging a toothed annulus 40 secured around the centre rim of the wheel. The driven speed may be of the order of 5 r.p.m.

The remaining two elevator wheels are substantially identical in construction to wheel 32 and are similarly supported and driven. Therefore like reference numerals are used but primed to indicate the second elevator wheel and double primed to indicate the third elevator wheel. The construction and operation of these wheels is self-explanatory.

The third elevator wheel 32'' discharges its contents onto a conveyor belt 42 carried on support rollers 43 rotatably mounted on the frame of the carriage 11. Wheeled supports 44 (FIGS. 2 and 3) running on tracks 45 in the bridge 13 carry grooved wheels 46 which are engaged by hooks 47 on the sides of cross bars 48 for supporting the feed run of the conveyor 42. The supports 44 move with the carriage as it traverses the bridge 13.

The frame 37 which supports the three elevator wheels 32, 32' and 32'' is pivotally mounted on the carriage 11 by means of a transversely extending pivot shafts 50 engaging bearing openings in the frame legs and the sides of the carriage 11. Two pairs of double acting hydraulic rams 51 are connected between the carriage 11 and the frame 37 to facilitate pivotal movement of the frame through about 15° to either side of the vertical. Similarly, the frame 25 is pivoted to the lower end of frame 37 (FIG. 3) and two double acting rams 52 extending between the two frames facilitate pivotal movement of the frame 25, in a direction mutually perpendicular to the pivotal movement of the frame 37, through about 45° to either side of the vertical.

The 15° movement of the main frame 37 to either side of the vertical enables the bucket wheel 20 to collect material in either wing W or the hold H well under the hatch coamings. The smaller diameter of second elevator wheel 32' facilitates greater pivotal movement before contact with the coaming.

The 45° of movement of the frame 25 supporting bucket wheel 20 enables the collection of material under the coaming near the fore and aft bulkheads of the hold H. The combined movements of the two frames facilitates access to the corners between the bulkheads and the wings.

It is believed that the dual swinging action of the sections of the unloader will facilitate removal of substantially all of material from a hold, leaving only non-

commercial amounts. This means that in most cases the usual use of a hold cleaning bulldozer should not be required. Similarly, where material is being removed from other containers or from open piles the unloader will operate to lift a larger volume before it is necessary to move the carriage or the support.

A further possibly more important advantage of the unloader described above resides in the use of rigid elevator wheels, preferably linked as shown, to collect the material from the bucket wheel or other suitable digger and deposit same on a conveyor or other discharging device at an elevated position relative to the collection point. It is believed that the use of such elevator wheels will result in a substantial improvement in the unloading rates of ores and other bulk materials from the holds of ore carriers together with lower shut down times for repair and servicing. Tests have been carried out on a one thirtieth scale test rig simulating the transfer arrangement between the digger wheel and first elevator wheel and they indicate satisfactory transfer characteristics between wheels. The results achieved also provide a conservative indication that a full scale model should achieve transfer rates of the order of 7,000 tonnes/hr. at 5 r.p.m.

Unlike the prior art bucket chain elevators having linkages and other moving parts which are prone to wear and failure, the present unloader consists of several wheels of rigid construction supported by reliable rollers which are relatively easy to service or replace. The wheel construction is also believed to have less weight than a comparable digging bucket chain elevator.

The mechanical details described above and shown in the drawings are for the purposes of illustration only and should not be regarded as limiting. For example, the bucket wheel may be replaced by a bucket chain of different configuration or by several smaller wheels feeding into the first elevator wheel. The driving means for the elevator wheels may be at positions and may operate other than as shown. For example, the support rollers may be driven to combine the two functions. Similarly, the number of wheels is not important; more or less wheels may be used as desired. A fifth wheel may be used discharging via a short transfer conveyor wheel in turn discharges onto a main conveyor at one side of the bridge. This arrangement would remove the need for the elaborate supports for the conveyor as shown in the drawings.

Similarly, the wheels (including the digging wheel) need not be arranged at 90° to each other, e.g., one or more of the wheels may be arranged off 90° in either direction to achieve better penetration under the coamings. Similarly, they need not be linked together in chain fashion as shown. For example as shown in FIG. 6 the wheels W1 to W4 may be parallel and adjacent each other with gravity feed from one to the other via inclined plates P1 to P3. Such an arrangement would possess similar advantages over the prior art bucket chain devices.

While the unloader has been shown mounted on an ore bridge this arrangement may be modified in many ways, some of which are as follows: The bridge need not be supported by only a single tower. A spur or breakwater may be built off-shore from a berth or berths sufficiently far off to admit the berthing of a large bulk carrier between it and the land based wharf. The spur would be free to support both

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rails and an outer support tower for the bridge. The main support tower could then be narrower and would not need to be counterbalanced, the nett result being a reduction in overall weight. The unloader may be supported by a gantry device travelling with it on the bridge. This would permit the unloader to be raised as far as the main conveyor permits and thereby minimise the overall height to which the bridge could be raised. The unloader may be carried aboard ship with a gantry support straddling the hatch openings and discharging onto cross feed conveyors or fore and aft shipboard conveyors.

To overcome the complexity of the conveyor support system now designed the main conveyor could be carried to one side of the bridge with a diagonal feed crossing the centre-line of the bridge as obliquely as possible. Similarly, a support may be introduced for allowing the wheels and support framework to rotate through 90° thereby possibly improving underdeck reach.

The upper ram arrangement illustrated may be modified by extending the frame 37 at the top and arranging the rams 51 horizontally with one end connected to the carriage 11 and the other end connected to the frame extension.

I claim:

1. A bulk material unloader including means for digging the material from a bulk supply, said digging means being arranged to discharge the collector material into an elevator means for raising the material to an elevated position with respect to the digging means, characterised in that said elevator means comprises a plurality of elevator wheels of rigid open channel cross section divided into a plurality of material retaining pockets, each wheel being rotatably mounted on a supporting frame in ascending relationship with respect to each other and each wheel being arranged to discharge the contents of its pockets by gravity into the pockets of the next most elevated wheel with the lowermost wheel receiving material from said collecting means, driving means for rotating said wheels at a substantially common speed, and means for collecting the material discharged from the uppermost elevator wheel.

2. A material unloader according to claim 1, wherein each wheel comprises a rim and sides extending substantially perpendicularly from the edges of the rim, and reinforcing sections secured to each side adjacent the free edges thereof, said wheels being rotatably supported by roller bearings running on said reinforcing

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sections and carried by said supporting frame.

3. A material unloader according to claim 1, wherein said wheels are linked together in chain fashion whereby the contents of the wheel are directly discharged from each pocket as it passes over the open channel of the wheel with which the first mentioned wheel is linked.

4. A material unloader according to claim 1, wherein each wheel comprises a rim and sides extending substantially perpendicularly from the edges of the rim, and reinforcing sections secured to each side adjacent the free edges thereof, said wheels being rotatably supported by roller bearings running on said reinforcing sections and carried by said supporting frame.

5. A material unloader according to claim 4, wherein said roller bearings are tapered and said reinforcing sections are correspondingly profiled.

6. A material unloader according to claim 1, wherein said digging means comprises a digging bucket wheel arranged to discharge its contents into said lower wheel.

7. A material unloader according to claim 1, wherein said wheels are arranged adjacent each other with their planes of rotation substantially parallel and in overlapping relationship, and gravity transfer chutes extending between discharge position of one wheel to the intake position of the next higher wheel.

8. A material unloader according to claim 1, wherein said digging means is supported by a frame which is pivotally mounted on the supporting frame for said elevator wheels, and means for pivoting said digging means frame transversely with respect to the longitudinal direction of said elevator supporting frame.

9. A material unloader according to claim 8, wherein said supporting frame is pivotally suspended from a supporting structure about an axis extending transversely to the pivotal axis of said collecting means frame, and means extending between said supporting structure and said supporting frame for pivoting said supporting frame about said axis.

10. A material unloader according to claim 1, further comprising an arcuate constraining plate mounted on said supporting frame inside each wheel and slightly spaced therefrom, said plate extending from a position about 45° from the bottom of each wheel to a position just short of the top of the wheel and acting to hold the material in said pockets.

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Disclaimer and Dedication

3,891,079.—*Howard Frank Roper*, Upwey, Australia. BULK MATERIAL UN-
LOADER. Patent dated June 24, 1975. Disclaimer and Dedication filed
Dec. 6, 1976, by the assignee, *The Broken Hill Proprietary Co. Ltd.*

Hereby disclaims and dedicates to the Public the remaining term of said pa-
tent.

[*Official Gazette January 26, 1982.*]