Sept. 20, 1971 T. B. THOMAS ET AL 3,606,038

ORE CARRIER WITH SLURRY REPULPING AND UNLOADING SYSTEM

Original Filed Feb. 5, 1969 2 Sheets-Sheet 1

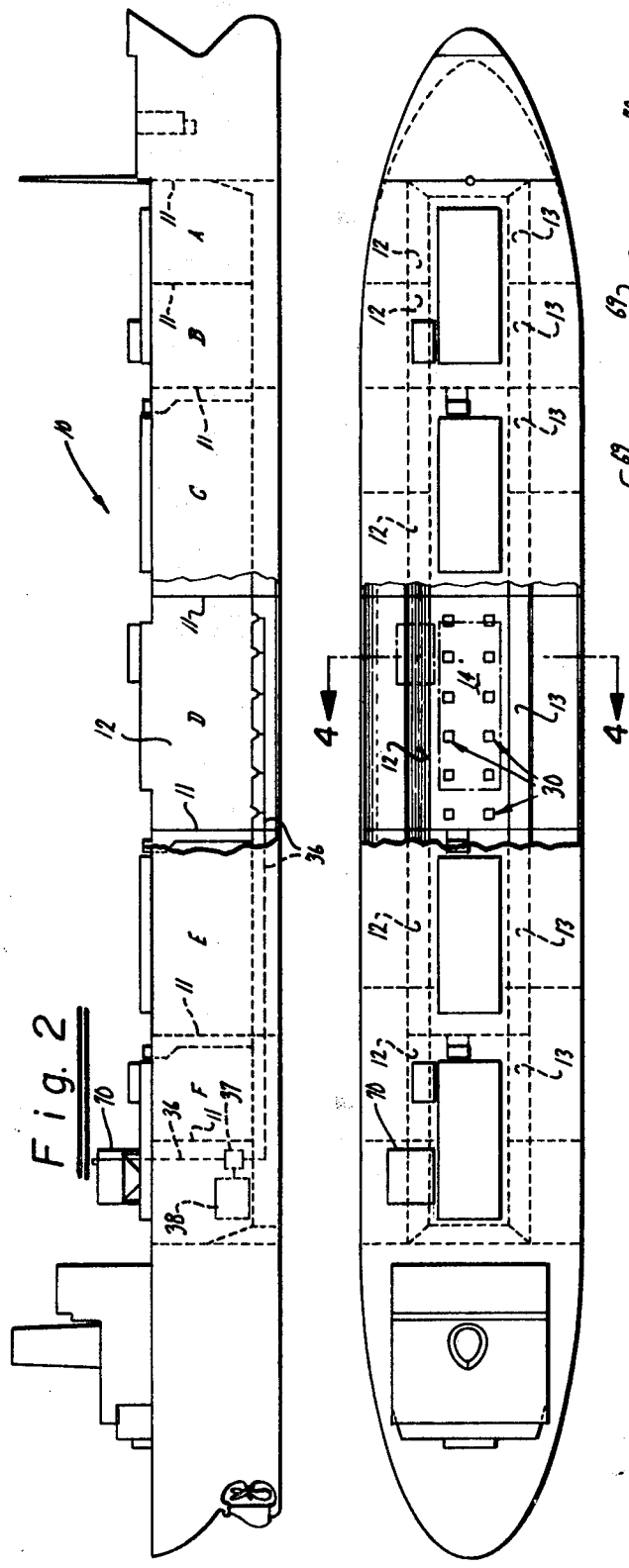


Fig. 2

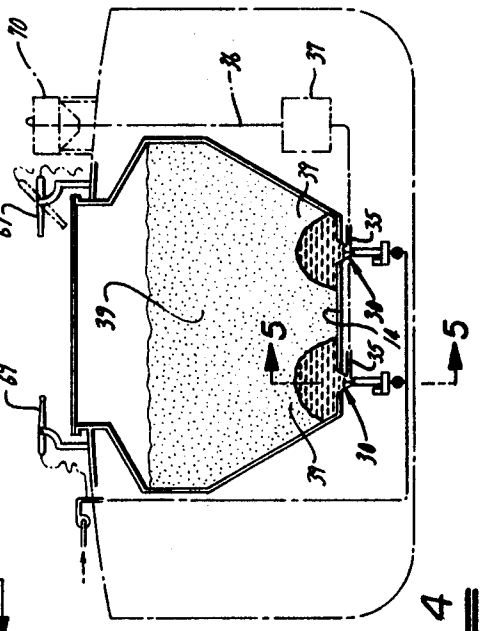


Fig. 4

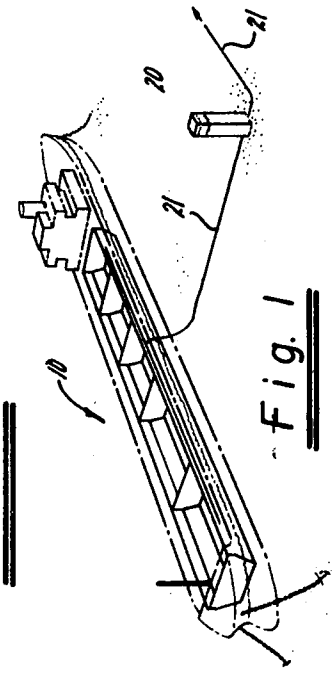


Fig. 3

Fig. 1

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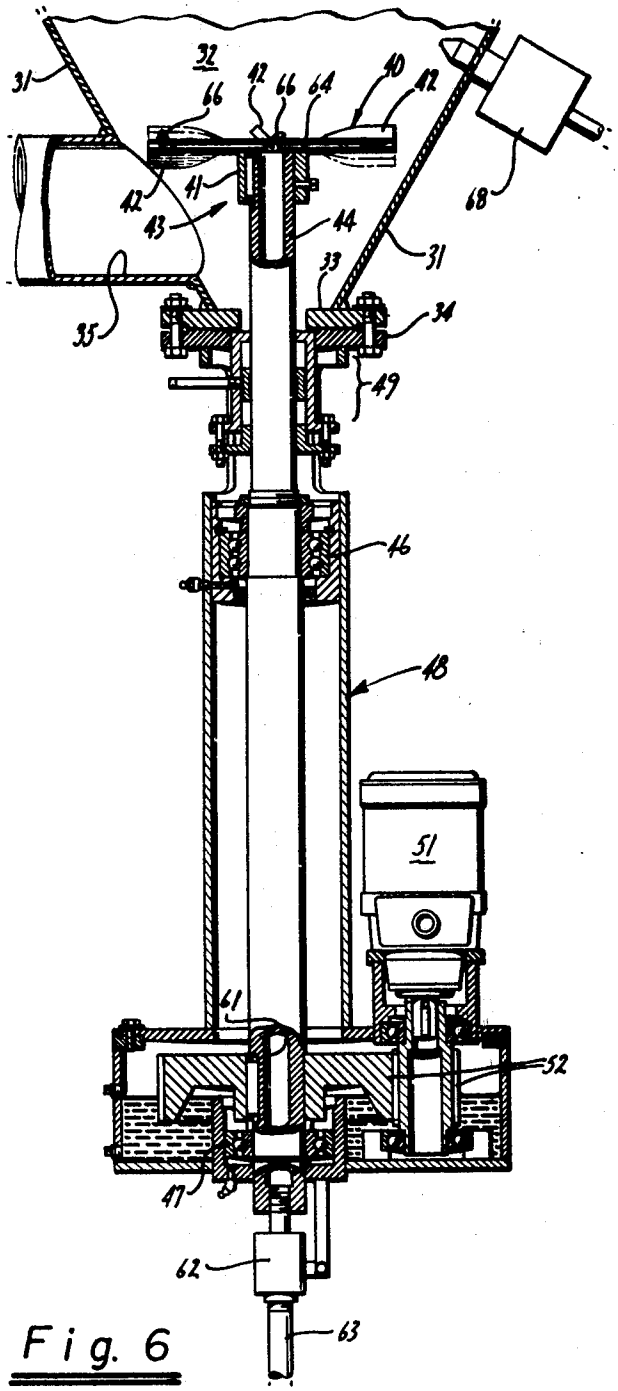


Fig. 6

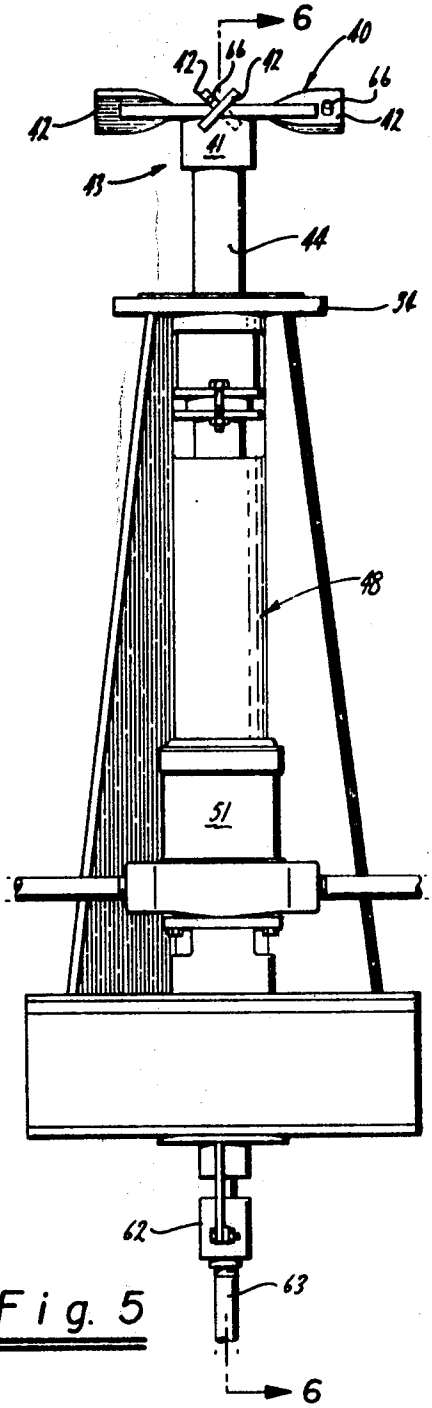


Fig. 5

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ORE CARRIER WITH SLURRY REPULPING AND UNLOADING SYSTEM

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Continuation of abandoned application Ser. No. 796,730, Feb. 5, 1969. This application Aug. 17, 1970, Ser. No. 64,579

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ABSTRACT OF THE DISCLOSURE

Ship's apparatus for slurry repulping using a sump formed in the inner bottom with a mechanical rotating impeller located in the sump and carrying hydraulic jets for continuously sweeping the vicinity of the sump to break up and cut away compacted particulate ore in the vicinity of the sump. Particular constructions of suitable ships for use with the invention are also disclosed.

This application is a continuation of application Ser. No. 796,730, filed Feb. 5, 1969, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to ore carriers and more particularly to such carriers which load, transport and discharge ore solids or other particulate matter.

Reference is made to copending application Ser. No. 778,364, filed 31 July 1968, entitled Method and Apparatus for Shipping Mineral Solids and Other Particulate Matter, in the names of Robert R. Beebe and Emmett J. Murphy, in which a system is set forth for the slurry loading, handling and discharging of ore solids. As stated therein, such systems find utility in the rapid discharging of particulate solids, especially ores, from ships. However, it is found that the movement of ore in ship's holds over considerable distances causes the ore solids to settle into a hard compacted mass. This settling is attributed principally to the vibrations of the ship's engines and gear and to the ship's motion in the seaway. The settled ore solids attain such a degree of compaction that they resemble a solid and are very difficult to resuspend into a slurry for unloading. In general, there is a need for new and improved ore carriers which facilitate repulping and discharging of settled ores in slurry form into shorebased piping systems.

As disclosed and claimed herein, the invention encompasses methods and apparatus involving the resuspending, diluting and resuspending of solid particles with a liquid, usually water, to form a slurry. The solids might be any of the solid particulate matter, soluble or insoluble, and the liquid might be fresh water, sea water or brine or even nonaqueous liquids. For purposes of setting forth an example of the invention herein, however, the disclosure is directed to the slurrification and handling of iron ore (magnetite) and concentrates in water-solids system. Such iron ore and concentrates can take various forms including typical products of ore dressing such as pellets and highly concentrated filter cake. As used herein, mineral solids includes ores, dressed ores, and all other particulate matter and ore products capable of being pulped into a pumpable slurry.

SUMMARY OF THE INVENTION AND OBJECTS

In general, it is an object of the present invention to provide a new and improved ore carrier for slurry unloading which is particularly effective in repulping settled

mineral particles into a completely resuspended slurry of pumpable consistency.

It is difficult to obtain a completely resuspended slurry in which all particles of the settled ore have been dislodged and suspended before being fed into the discharge lines, that is to say, free of clumps which would clog the system. Also, such settled material is sufficiently strong, when compacted, that it is self-supporting even when portions are cut away from below, as when using only stationary water jets.

It is another object, therefore, to provide apparatus which will assure positive break-up and complete disintegration of clumps so that a completely resuspended slurry is fed to the discharge piping.

A further object of the invention is to facilitate repulping and avoidance of bridging of compacted solids by continuously shifting the position of attack of water jets.

A further object is to provide such resuspended slurry to the discharge piping under a slight positive pressure.

In general, the above objects are achieved by suitably constructed apparatus incorporated into the structure of a ship's hold. The ship includes suitable bulkheads and an inner bottom for subdividing it into cargo holds. At least one sump is formed in the bottom of each hold which is provided with discharge piping including a slurry pump connected through a wall of the sump. A mechanical agitator is mounted within the sump and includes an axial flow impeller having a hub and one or more blades extending outwardly from the hub together with means for mounting and rotating the impeller. A high pressure hydraulic injector is provided for forming a water jet in association with the outer end of each blade and is constructed and arranged to move with the blade to aid in subdividing and repulping adjacent mineral solids into a completely slurrified form. As the blade moves, it not only engages the water and solids in its vicinity but it also carries the hydraulic stream or jet in an arcuate path to thereby cause it to continuously attack fresh material. Preferably, the impeller has a plurality of blades which further serve to impart downwardly directed, positive discharge pressure to the reslurrified material in the sump.

These and other features and objects of the invention will be apparent from the following description in which the preferred embodiment is set forth in detail when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a ship of the present invention moored offshore and connected to a suitable piping for pumping its contents ashore.

FIG. 2 is an elevational view of a ship constructed in accordance with the present invention and showing one cargo hold thereof cut away to reveal its manner of construction.

FIG. 3 is a plan view of a ship constructed in accordance with the present invention and showing portions of a cargo hold cut away to reveal its construction.

FIG. 4 is a cross sectional view of a ship's hold taken along the lines 4—4 of FIG. 3.

FIG. 5 is an enlarged detailed view of repulping apparatus constructed according to the present invention and taken along the lines 5—5 of FIG. 4.

FIG. 6 is a cross sectional view taken along the lines 6—6 of FIG. 5.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 through 6, there is shown a slurry ore carrier constructed in accordance with the present invention which is provided with a plurality of watertight holds A–F formed by transverse bulkheads 11,

longitudinal bulkheads 12, 13 and inner bottom 14. The ship is serviced and connected to shore by a suitable pumping station and submerged pipelines. Alternatively, the ship can dock at conventional port facilities if such are available. In general, the ship will be loaded with particulate ore solids as by dry loading, or slurry loading with decanting of excess liquid. In transit, the ore solids tend to settle into a hard mass or cake, which it is desired to resuspend and off-load by adding water and repulping the solids into a pumpable slurry with suitable apparatus, now to be described.

Each slurry hold is provided with at least one sump 30, each of which is formed with side and endwalls 31, 32 peripherally connected to the inner bottom 18 and converging downwardly below the inner bottom to a bottom wall 33 including a flange 34. Discharge piping 35 is connected through one of the sidewalls of the sump and may include slurry discharge pump (not shown) which can be of any suitable type such as a centrifugal pump. Preferably, however, the piping 35 connects into a discharge header line 36 which runs longitudinally through the ship's bilges to a pumproom including a slurry pump 37 and prime mover 38 located in the aft hold section just forward of the machinery space.

Means are provided for positively repulping settled slurry 39 in the vicinity of the sump and consists of an impeller 40 or propeller which takes the form of a hub 41 provided with a plurality of outwardly extending blades 42. The impeller is mounted for rotation on the upper end 43 of a hollow shaft 44 set in spaced bearings 46, 47 vertically aligned and mounted in a housing 48 secured to flange 34 so that the shaft extends upwardly into the sump. A suitable gland 49 is provided between the upper bearing and the sump to seal out abrasive material. Shaft 44 is rotated by means of positive displacement hydraulic motor 51 which is connected to it through a suitable rotation transmission device such as gearing 52. The blades are constructed with a fixed or developed (helical) pitch of a type suitable for inducing axially directed pressure, and is preferably rotated in a sense which serves both as a repulping mixer and as a means of developing a positive, downwardly directed pressure on the slurry as it is injected into the discharge piping.

Means are provided for forming a water jet for travel in association with the outer end of each of the blades. Such means includes the interior 61 of the hollow shaft, the lower end of which terminates and rotates in a fixed rotary union or seal assembly 62 for effecting seal with suitable high pressure water piping line 63 (about 250 pounds per square inch). The upper end of the shaft is closed by the impeller hub and its interior communicates with passageways 64 formed in the impeller which connect to water cutting jet means formed at the outer end of the blades. Such means can take the form of nozzles or orifices 66 formed at the blade tip and canted both generally away from the direction of motion of the blade and upwardly to penetrate and cut away compacted material in the vicinity and to help promote repulping and slurrification.

Additional high pressure jet nozzles 68 are mounted in the sidewalls of the sump and are directed upwardly to provide additional agitation and hydraulic forces for breaking up material that may have bridged above the sump. Also, high pressure monitors 69 are preferably maintained at deck level and can be trained into the hold to direct high volume, high force water simultaneously with the action of the jets associated with the sump to thereby cooperate in cutting away compacted material mineral solids and move them into the vicinity of a sump.

Operation of the apparatus is as follows: the hydraulic pressure to the cutting jets 66 and 68 is turned on and the impeller rotation speed is adjusted within a range up to about 300 revolutions per minute. As the impeller rotates, jets 66 send out a plurality of hydraulic streams of high force which continuously move in arcuate paths about a

circle. These streams, in cooperation with the fixed high pressure streams from jets 68, work on the compacted material, causing it to break up and fall toward the sump. As the broken material enters the sump, the impeller positively agitates and repulps it by direct action of the blades on the material and by the motion of the surrounding liquid. The impeller also exerts a positive downward force which aids in stabilizing the outward flow of the repulped slurry to the discharge lines. If desired, the jet streams can be provided with a pulsating component to aid in cutting away the compacted solids. Slurry pumped out of discharge piping can be pumped directly into piping 21 or can be supplied to an intermediate, deck-mounted surge tank 70.

Thus, there has been provided novel and useful apparatus for resuspending a cake of particulate ore solids into slurry form and for continuously pumping the resulting slurry out of a ship's hold. The combined action of the impeller and water cutting jets effectively serve to cut away caked material and to aid in pumping it out the discharge piping. While preferred apparatus have been disclosed herein, it is to be understood that many departures from these specific disclosures can be practiced within the spirit and scope of the invention which is limited only by the appended claims.

We claim:

1. A slurry carrier for transporting particulate mineral solids comprising a ship including bulkheads and an inner-bottom forming at least one watertight cargo hold therein for containing solids or a slurry thereof suspended in a liquid, at least one sump formed in the innerbottom of said hold and having side and bottom walls, discharge piping including a slurry pump connected through a wall of said sump, a mechanical mixer comprising an impeller having a hub and at least one blade extending outwardly from said hub, said blade having a pitch for exerting a force on material in said sump in a direction away from said blade and axially thereof, means for mounting and rotating said impeller within said sump, in a sense such that a positive downward thrust is created for causing material in said sump to be ejected into said discharge piping, means forming a water jet in association with said impeller and constructed and arranged to move therewith to thereby aid in repulping settled solids into a slurrified form of pumpable consistency within said sump.

2. A carrier as in claim 1 in which said impeller includes a plurality of blades having a low pitch.

3. A carrier as in claim 1 in which said means mounting and rotating said impeller comprises a hollow shaft, means for mounting said shaft for rotaton, means for rotating said shaft, said last named means being free of the lower end thereof, a rotary union affixed to the lower end of said shaft and making a seal therewith, said union adapted to be connected to a source of high pressure water, and means for connecting said means forming a water jet to the interior of said shaft and further in which said blades carry said means forming a water jet.

References Cited

UNITED STATES PATENTS

84,901	12/1868	Pease	259—23
512,865	1/1894	Collins	214—15B
1,750,095	3/1930	Ewig	214—15B
2,592,904	4/1952	Jackson	259—8X
3,202,281	8/1965	Weston	259—8X
3,421,639	1/1969	Oka et al.	214—15
3,445,008	5/1969	Koch	214—14

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