Nov. 2, 1954 J. R. SENSIBAR 2,693,282

HOPPER

Filed July 24, 1951 4 Sheets-Sheet 1

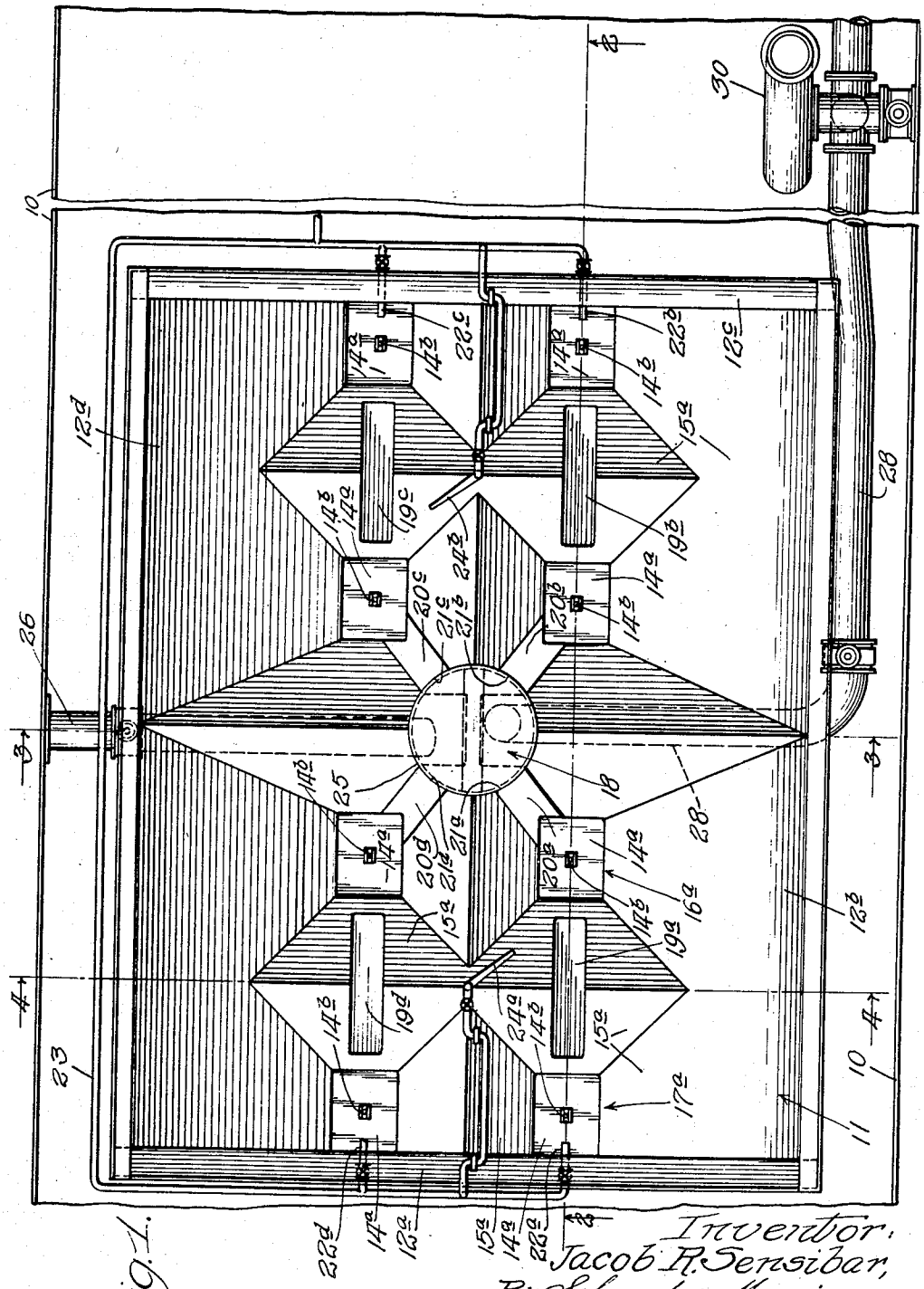


Fig. 1.

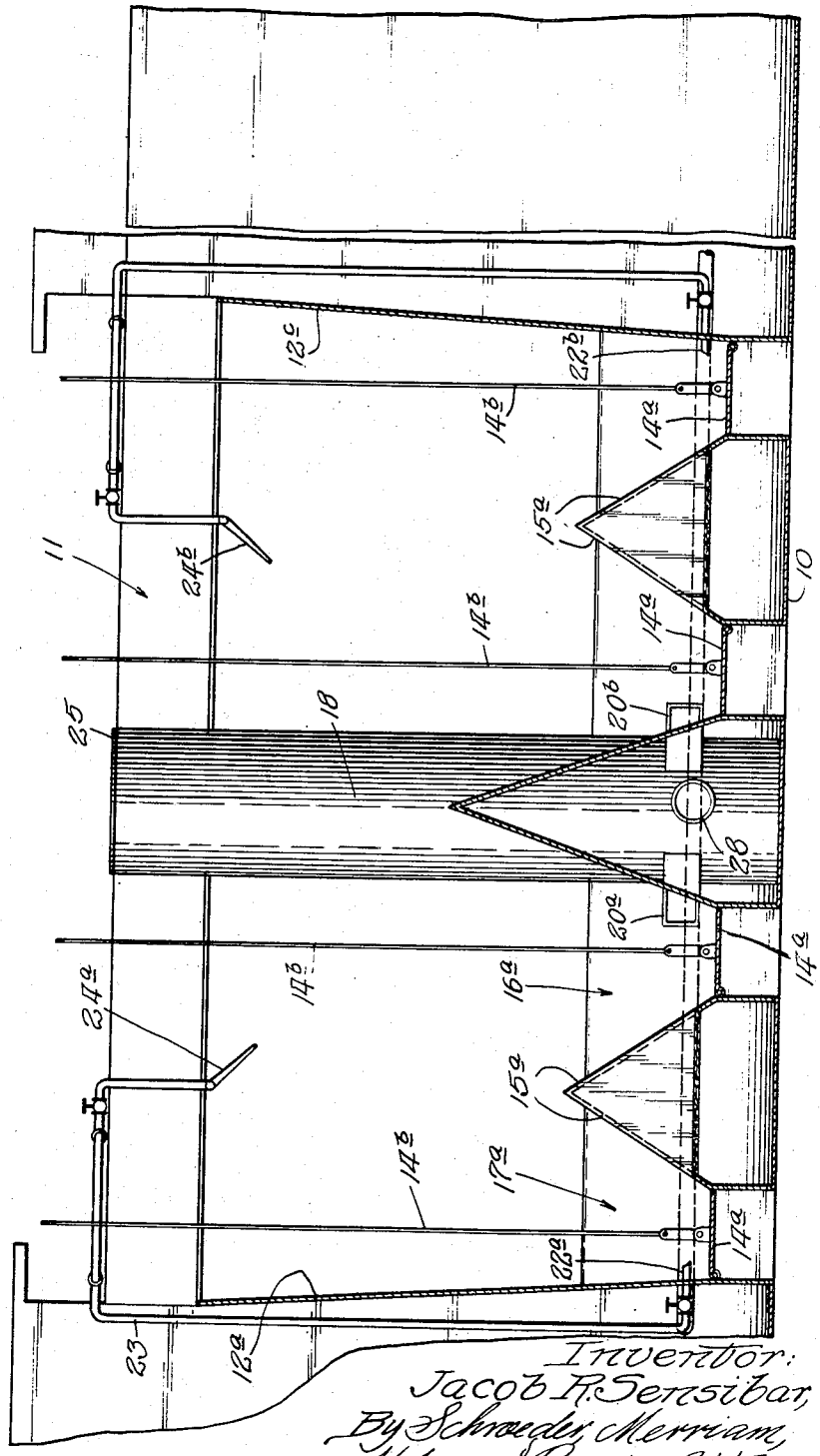
Inventor,
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Fig. 2.



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Fig. 3.

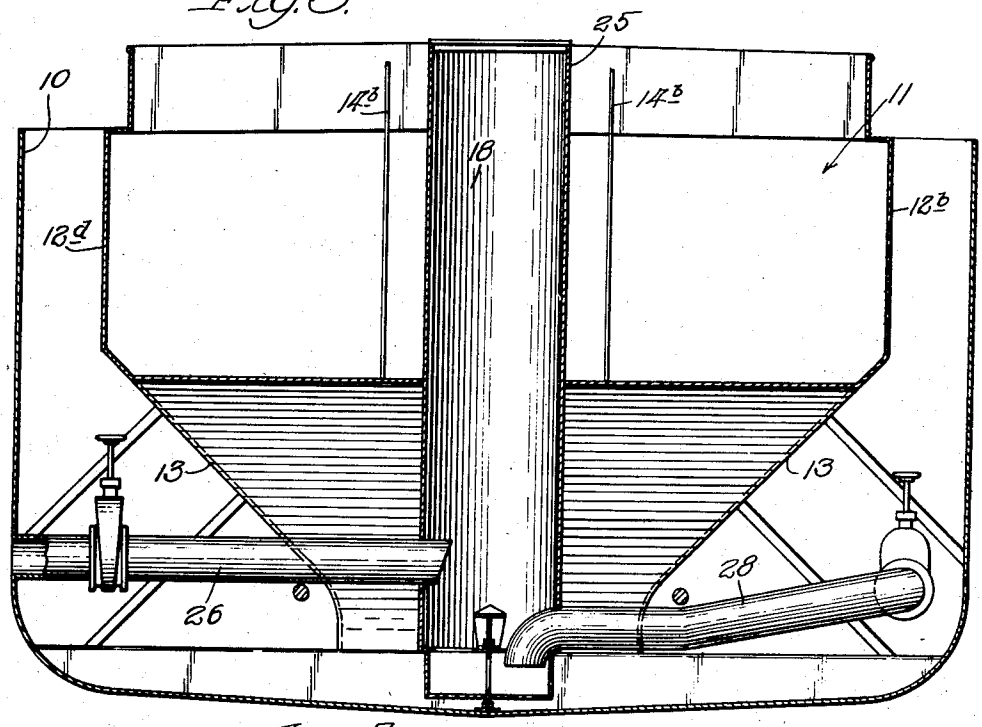
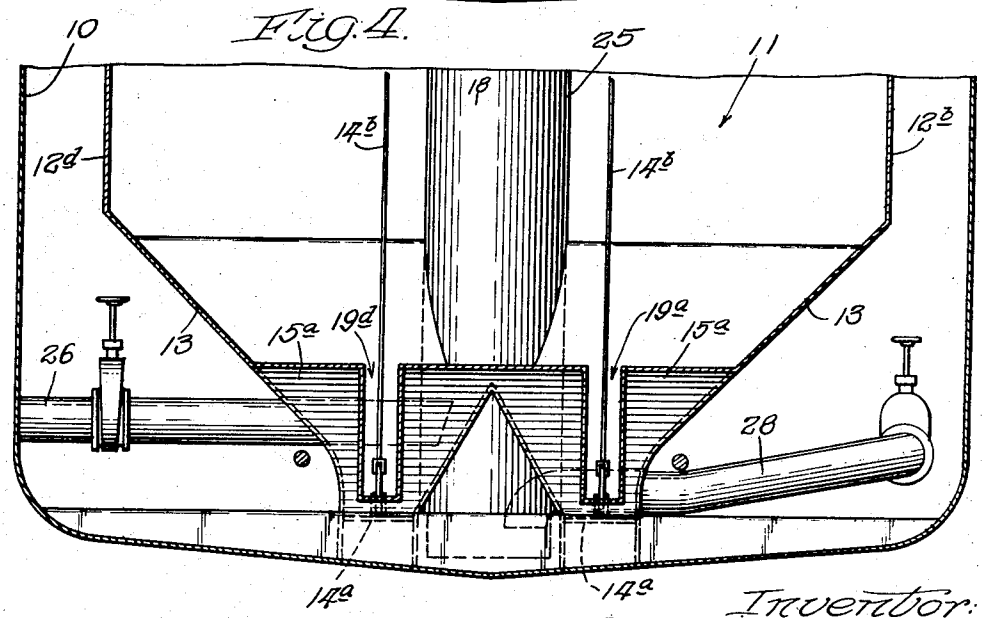


Fig. 4.



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Fig. 6.

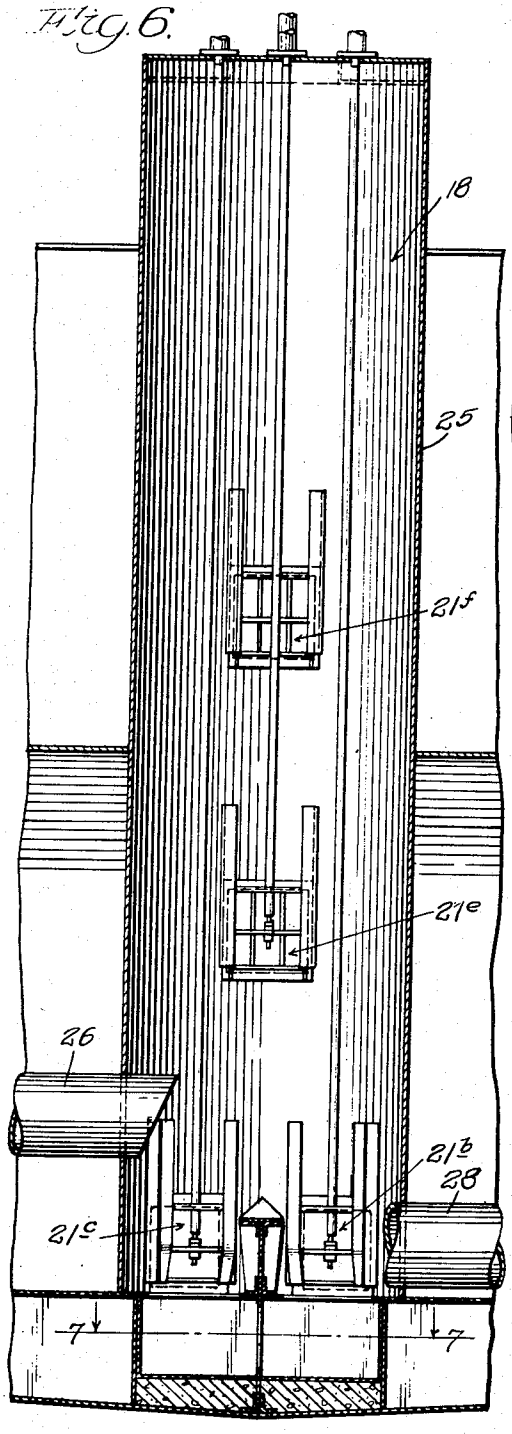


Fig. 5.

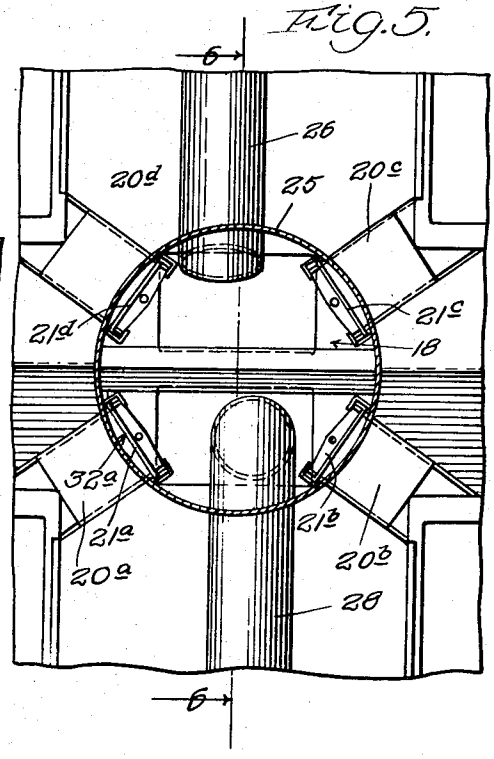
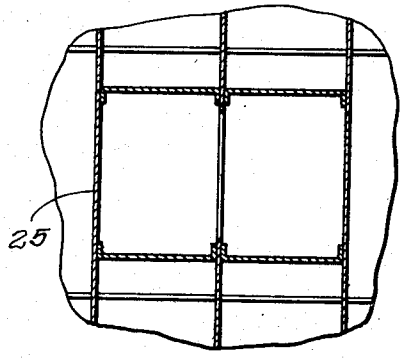


Fig. 7.



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2,693,282

HOPPER

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Application July 24, 1951, Serial No. 238,354

6 Claims. (Cl. 214—15)

This invention relates to apparatus for handling free flowing material and more particularly to apparatus for unloading sand or sand and gravel from a ship.

In recent years the establishment of stock piles of sand or other free flowing material and land reclamation has become increasingly important. An efficient and economical method of accomplishing this has been to suck sand or other free flowing material from the bottom of a body of water into hoppers of a ship, dewater this sand and transport it to a landing berth where pipe lines on shore are connected to the ship. Water is then added to the sand in the hoppers and the desired proportion of sand and water mixture is pumped from the ship to the desired area through the pipe lines on shore.

In hydraulically unloading sand from a ship's hoppers, it is necessary that they be emptied rapidly and completely without permitting the ship to list substantially due to continual shifting of the water in the hoppers as the sand and water mixture is being discharged from the ship. In the past, a substantial quantity of the sand remained in the hopper after hydraulic unloading.

This invention provides apparatus for unloading a ship which accomplishes all of the desired features enumerated above as well as others which will appear more fully hereinafter. By the use of this invention, substantially all of the sand or other free flowing material contained in the hopper of a ship may be rapidly unloaded in the form of a free flowing material and water mixture which can be transported through pipes great distances inland where it can be stock piled or deposited to build up and reclaim areas of land. The term "free flowing material" is meant to include earth, mud, sand, gravel, coal and the like or mixtures of these materials.

The invention will be described with reference to preferred embodiments illustrated in the accompanying drawings, in which:

Figure 1 is a fragmentary plane view of a hopper located in the aft portion of a ship;

Figure 2 is a vertical section along line 2—2 of Figure 1;

Figure 3 is a vertical section along line 3—3 of Figure 1;

Figure 4 is a vertical section along line 4—4 of Figure 1;

Figure 5 is an enlarged fragmentary sectional view of the mixing well located in the central portion of Figure 1;

Figure 6 is a vertical section of the mixing well taken along line 6—6 of Figure 5; and

Figure 7 is a fragmentary sectional view taken along line 7—7 of Figure 6.

The particular ship illustrated in Figures 1–4 has a hull **10** constructed in accordance with the usual marine practice. Mounted in this hull are a series of bins or hoppers adapted to receive and retain sand or other free flowing material which is sucked up from the bottom of the sea. These hoppers are centrally located with respect to the longitudinal center line of the ship and are supported by a frame work system within the hull which is not shown in the drawings as it is not a part of this invention and would only serve to complicate the drawings.

The particular hopper **11** shown in the drawing and embodying this invention has four side walls **12***a*, **12***b*, and **12***c*, and **12***d*, the lower portions of which taper inwardly toward the floor or bottom of the hopper as indicated by **13**. Eight adjoining hopper elements occupy substantially the entire bottom of the hopper. Each element is composed of a bottom, as **14***a*, surrounded by side walls, as **15***a*, which slope downwardly toward the bottom. It is preferred that the tapered portions of the hopper walls

and the surrounding side walls of each hopper element be disposed at angles from the horizontal which are at least slightly greater than the angle of repose of the wet, free flowing material to be emptied from the hopper to assure even, rapid movement of the free flowing material in the hopper.

In the particular embodiment shown, each hopper element bottom, as **14***a*, is a standard hinged, dump gate or door adapted to be opened to the sea through the bottom of the ship to enable rapid unloading by dumping of the material in the hopper into the sea without substantial listing of the ship when it is desired to unload the material through the bottom of the hull. Each gate has a rod, as **14***b*, extending in an upwardly direction. The bottom end of this rod is hingedly connected to the gate and the upper portion may be connected to a lever arm or other actuating mechanism not shown in the drawings for moving the rod up or down thereby closing or opening the gate to the sea. It is to be noted that when the gates are in a closed position they substantially seal the bottoms from the sea.

As shown in Fig. 1, each quadrant of the hopper bottom contains a pair of hopper elements, a feeding element, as **16***a*, located substantially adjacent the center of the hopper bottom and a remote element, as **17***a*, adjacent to and directly behind the feeding element **16***a*. Each pair of these elements adjoins the pairs in the two bordering quadrants. It is to be noted that in this particular embodiment (Fig. 2) the side walls of adjacent hopper elements form an inverted V and are secured together, as by welding, along their lines of intersection. In addition, the bottom portion of the tapered hopper walls form two surrounding side walls of each remote element and one of the surrounding side walls of each feeding element.

When hydraulically unloading free flowing material, such as sand, from the hopper, a water carrier is employed to move the sand from the hopper into the mixing well **18** through a series of openings **21***a*, **21***b*, **21***c*, **21***d*, **21***e* and **21***f* in the wall of the well compartment. This well is located substantially in the center of the bottom of the hopper and among other things serves to condition the sand for discharge from the ship. A series of connecting ducts **19***a*, **19***b*, **19***c*, and **19***d* and feeding ducts **20***a*, **20***b*, **20***c*, and **20***d* aid in conducting the sand and water carrier mix to the well openings. A separate connecting duct, as **19***a*, open at the top, cuts through the adjacent sloping side walls of each pair of elements in each quadrant connecting the bottom portions of the remote element, as **17***a*, and the feeding element, as **16***a* and is substantially aligned with the bottoms of the elements. A separate feeding duct, as **20***a*, substantially aligned with the bottoms of the hopper elements and of the same construction as the connecting ducts leads from the bottom portion of each of the four feeding elements to one of the compartment openings **21***a*, **21***b*, **21***c*, or **21***d* in alignment with it. While the ducts shown are open at the top and in effect are trough-like, pipes or other connecting passages may be substituted.

The particular means used in this invention for furnishing the water carrier and moving the water carrier and sand mix to the mixing well **18** from the hopper is a series of water jets directed into the hopper from valve controlled jet nozzles. Mounted on the bottom portion of the hopper side walls **12***a* and **12***c* opposite the ends of the connecting ducts are four jet nozzles **22***a*, **22***b*, **22***c*, and **22***d*, each located slightly above the bottom of each remote element in alignment with a connecting duct. The nozzles are directed downwardly so that water jetting therefrom impinges on the bottoms of the remote hopper elements and also jets into the connecting ducts. Water is thereby added to the sand as a carrier and the resulting sand and water mix is moved by the jets from the remote hopper elements through the connecting ducts to the feeding elements and from there through the feeding ducts into the mixing well **18**. As a further aid in moving the sand in the hopper into the well **18**, two additional valve controlled water jet nozzles **24***a* and **24***b* are mounted above the hopper in centrally located positions with respect to the top of the hopper. Manually operated, they are so adapted as to direct a stream of

water into the hopper from above and can be rotated horizontally through 360° and vertically through 180° in a downwardly direction. To furnish water to the above jetting nozzles, pipe **23** is connected to each nozzle and leads to a water pump source not shown in the drawings.

In order to discharge a sand and water mixture from the ship and into pipe lines, it is preferred that the mix so discharged be of certain proportions to enable efficient pumping and handling. In addition, this should be done quickly and efficiently without any substantial listing of the ship as the sand is emptied from the hopper. As an aid in satisfying these conditions, a mixing well **18** may be provided. In the particular embodiment, best shown in Figs. 1 and 5–7, it is located substantially in the center of the bottom of the hopper, serving among other things as the means for properly conditioning the sand and water mix flowing from the hopper for discharge. It is made up of a compartment **25** having a cylindrically shaped wall extending from slightly above the bottom of the ship through the bottom portion of the hopper to the top of the hopper. The valve controlled flood pipe **26** extends into the well, opening thereto at a point above the bottom of the hopper. The other end leads to an opening in the side of the ship below the water line not shown in this drawing. This pipe serves as a means for supplying added water by gravity flow to the wet sand flowing into the well to properly condition it for discharge from the well.

A series of openings **21***a*, **21***b*, **21***c*, **21***d*, **21***e* and **21***f* in the compartment of the well are provided at different heights and are controlled by self-seating, sliding doors, as **32***a*. See Fig. 6. As shown in the Figs. 1 and 6 the latter two openings are located at vertically spaced intervals from each other above the hopper bottom. The four lower openings are aligned with the feeding ducts **20***a*, **20***b*, **20***c* and **20***d* respectively.

In hydraulically unloading sand or other free flowing material from the hopper, a mixture of sand and water carrier is moved towards the mixing well by the jetting action of the water from the above mentioned jet nozzles and aided by gravity flow. This mix is discharged into the mixing well through the openings **21***a*, **21***b*, **21***c*, **21***d*, **21***e* and **21***f* in the compartment where it is conditioned for discharge by adding controlled and measured amounts of flooding water from the flood pipe **26**. The desired mixture is then sucked up through the suction pipe **28** connected to the discharge pump **30** and from this pump delivered to pipes on the shore which are not shown in the drawing.

The foregoing detailed description is given for clearness of understanding only and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

1. In a sand carrying ship, a hopper having a bottom comprising a plurality of adjoining, free flowing material collecting hopper elements occupying substantially the entire bottom of the hopper, each element having surrounding side walls sloping toward the bottom of the hopper element; connecting ducts cutting through certain adjacent side walls of adjoining hopper elements to provide a path substantially aligned with the bottoms of the hopper elements for conducting a mix of water and free flowing material between the hopper elements; a mixing well for receiving the mix from the elements and conditioning it for discharge; feeding ducts leading from certain hopper elements to the mixing well for conducting the mix in the elements into the mixing well; water jetting means directed along the lower portion of certain hopper elements for supplying water to the free flowing material in the hopper and moving the mix with the aid of gravity flow from the hopper elements into the mixing well through the connecting and feeding ducts.

2. In a sand carrying ship, a hopper having a bottom comprising at least four pairs of adjoining, free flowing material collecting hopper elements occupying substantially the entire bottom of the hopper, each pair of elements having a separate connecting duct cutting through adjacent, sloping side walls between the two elements to provide a path substantially aligned with the bottoms of the hopper elements for conducting a mix of water and free flowing material between the two elements of each pair; a mixing well for receiving the mix from the hopper elements and conditioning it for discharge; a separate feeding duct for each pair of hopper elements leading from the bottom portions of at least one element of each pair to the mixing well for conducting the mix in each pair to the mixing well; water jetting means directed along the lower portion of certain hopper elements for supplying water to the free flowing material in the hopper and moving the mix from the hopper elements to the mixing well through the connecting and feeding ducts.

3. In a sand carrying ship, a hopper having a bottom comprising at least four pairs of adjoining, free flowing material collecting hopper elements occupying substantially the entire bottom of the hopper, each element having surrounding side walls sloping toward the bottom of the hopper elements; a connecting duct for each pair of elements, said duct cutting through adjacent sloping side walls of each pair of elements to provide a path substantially aligned with the bottoms of the hopper elements for conducting a mix of water and free flowing material between the elements of each pair; a mixing well located substantially in the center of the bottom of the hopper, said well being provided with means for supplying water to the mix to condition it for discharge and a passage for conducting the conditioned mix away from the well; a feeding duct for each pair of hopper elements cutting through the sloping side walls of at least one of the hopper elements of each pair and leading to the mixing well for conducting the mix in each pair of elements to the mixing well; water jetting means directed along the lower portion of certain hopper elements of each pair for supplying water to the free flowing material in the hopper and moving the mix with the aid of gravity flow from the hopper element to the mixing well through the connecting and feeding ducts.

4. In a sand carrying ship, a hopper capable of being substantially emptied of all free flowing material contained therein, said hopper having a bottom comprising at least eight adjoining, material collecting hopper elements occupying substantially the entire bottom of the hopper, each quadrant of the bottom being composed of a pair of the elements, a feeding element being adjacent the center of the bottom and a remote element occupying a position removed from the center and adjacent the feeding element; a separate connecting duct for each pair of elements substantially aligned with the bottom of the elements and connecting the remote and feeding elements for conducting a mix of water and free flowing material between the elements of each pair; a mixing well located substantially in the center of the hopper bottom, said well being provided with means for supplying water to the mix to condition it for discharge and a passage leading from the well to a discharge pump; a discharge pump; a separate feeding duct for each pair of elements leading from the bottom portion of each feeding element to the mixing well for conducting the mix to the well; and separate water jets for at least each pair of elements directed along the lower portion of each remote element in a direction so as to move the mix with the aid of gravity flow from the remote element through the connecting duct to the feeding element and through the feeding duct to each pair to the well.

5. Apparatus as specified in claim 4 wherein each hopper element has surrounding side walls sloping toward the bottom and disposed at an angle from the horizontal which is at least slightly greater than the angle of repose of the wet free flowing material to be emptied from the hopper.

6. The apparatus as specified in claim 5 wherein the sloping side walls of the hopper are disposed at an angle from the horizontal which is at least slightly greater than the angle of repose of wet, free flowing material to be emptied from the hopper.

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