

PATENT SPECIFICATION

(11)

1285894

1285894

DRAWINGS ATTACHED

- (21) Application No. 54725/69 (22) Filed 7 Nov. 1969
 (31) Convention Application No. 6815921 (32) Filed 8 Nov. 1968 in
 (33) Netherlands (NL)
 (45) Complete Specification published 16 Aug. 1972
 (51) International Classification B63B 35/30
 (52) Index at acceptance B7A 1
 (72) Inventor JAN DE KONING



(54) METHOD OF LOADING A HOPPER

(71) We, N.V. INGENIEURSBUREAU VOOR SYSTEMEN EN OCTROOIEN "SPANSTAAI", a Dutch Limited Liability Company, of 132, Binnenweg, Rotterdam, The Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a method of loading a hopper of a floating vessel with dredging spoil such as, for example, sand.

In a known method, as a first step a suspension of sand and water is pumped into the hopper. When the hopper is completely filled, the hopper contains only a small quantity of sand. In a second step, additional suspension is pumped into the hopper whilst an equal volume is drained off until there is no further increase in the quantity of sand in the hopper.

The settling of the sand depends on the size of the grains and the flow velocity of the suspension. In a given hopper cross-section the free flow area above the settled sand decreases as sand settles, resulting in an increase in the flow velocity of the suspension up to a value at which further settlement of sand is prevented. At this value of the flow velocity of the suspension pumped into the hopper, the additional suspension is drained off with all its sand. The quotient of the sand volume and the hopper volume, which sand volume can be reached with a given grain size of the sand, a given capacity of the pump and a given hopper cross-section, is called the bulking factor.

As the specific gravity of wet sand is about 2, the hopper of the known vessel has a volume substantially equal to half the vessels maximum permissible varying volume for the suspension of sand and water.

As such a hopper cannot be filled completely with sand owing to the bulking factor, it has been already proposed to provide a hopper with an upstanding upper edge comprising draining-off flaps whereby the hopper can be loaded with a little more sand owing to the increased free flow area above the settled sand. In a third loading step during

which no suspension is pumped into the hopper, the sand is allowed to settle and then water is drained off by suddenly lowering the draining-off flaps. This third loading step may be repeated.

The present invention has the object of shortening the loading time.

The present invention in a first aspect consists of loading a hopper of a floating vessel with dredging spoil including a first step of supplying a suspension of the dredging spoil in water to the hopper until the vessel is loaded to a preselected weight and a second step of supplying additional suspension to the hopper whilst water in the hopper is drained off by lowering draining means in the hopper in dependence on the weight of the load in the hopper so that the vessel is maintained loaded at substantially the preselected weight.

The invention in a second aspect consists of a floating vessel comprising a hopper with height-adjustable draining means, the height of the draining means in the hopper being controlled by load-measuring means.

Preferably a delivery pipe adapted to deliver a suspension of dredging spoil in water is connected to the pressure side of a pump on the vessel.

The volume of the hopper may be so great that when the hopper is substantially completely filled at the end of the first step of the method of the invention with suspension the vessel is loaded to its maximum loading capacity. If the suspension has a specific gravity of about 1.2 the hopper is filled only up to 20% with sand at the end of the first step. No more suspension may be pumped into the hopper without draining off, otherwise the maximum permissible loading capacity of the vessel would be exceeded. Therefore in performing the second step of the method the draining means are put in operation as soon as the vessel is loaded up to its maximum permissible loading capacity during simultaneously supplying of additional suspension into the hopper.

For safety the draining means preferably have a capacity exceeding the capacity of the pump supplying suspension to the hopper.

Preferably the draining means comprise at least one drain syphon having a height-adjustable inlet.

For safety, the vessel according to the invention preferably includes a safety device which is controlled by the load-measuring means and which becomes operative if the weight of the load of the hopper exceeds a predetermined value. This safety device may actuate an alarm device, may put the pump applying the suspension in the hopper out of action and/or may in case of emergence put in operation unloading means for discharging sand from the hopper.

It is an additional advantage that owing to the vessel being loaded in a short time up to its maximum permissible loading capacity, the pump of the vessel is lowered to a great extent relatively to the water level soon after starting the loading operation, resulting in increase of suction force of said pump of about 1m water column.

The invention will now be described, by way of example, with reference to the accompanying drawings in which:—

Figures 1a and 1b show graphs of a known method for loading a known suction dredger, Figure 1c shows a cross section of the known suction dredger,

Figures 2a and 2b show graphs of a method, embodying the invention, for loading a suction dredger,

Figure 3 shows a longitudinal section of a preferred embodiment of a suction dredger according to the invention,

Figure 4 shows a plan view of the suction dredger of Figure 3 and

Figure 5 shows diagrammatically a control and safety device of the suction dredger of Figures 3 and 4.

In Figures 1a and 2a broken lines show the total volume V_t of suspension and settled sand and solid lines show the volume V_s of settled sand at any time during the loading operation.

In Figures 1b and 2b broken lines show the total weight W_t of suspension and settled sand and solid lines show the weight W_s of settled sand at any time during the loading operation.

In comparing the method according to the invention with the known method, Figures 1 and 2 are based on suction dredgers with equal maximum permissible loading capacities W_G and pumps which can pump suspensions at equal rates into the hopper, said suspensions having equal proportions of sand.

For transporting volume V_{SH} of wet sand (Figure 1a) in the known method, a suction dredger is used having a maximum hopper volume V_R which can be reduced by means of lowerable draining-off flaps 6 to a volume V_D . In carrying out the known method, suspension is pumped into the hopper 2 of the suction dredger 1 of Figure 1c during a first

loading step 3 starting at the point of time O and ending at the point of time A at which the hopper 2 is completely filled up to its upper edge 5. The hopper 2 has draining-off flaps 6 raised during the first loading step 3. In this first loading step 3 the volume V_s and also the weight W_s increase considerably. During the subsequent loading step 4 in the period AD suspension is continuously pumped into the hopper 2, liquid being drained off to an equal extent. The proportion of sand in this drained-off liquid increases gradually. The volume of sand settling per time unit is so little at the point of time D, that continuation of the second loading step 4 is no longer efficient. For this reason the operation of pumping suspension into the hopper 2 is stopped and during a third loading step 7 the sand of the suspension is allowed to settle. At the point of time E the draining-off flaps 6 are lowered into the draining-off position 6', for draining off the upper water. The hopper volume is then V_D . In a subsequent fourth loading step 8 the draining-off flaps 6 are raised and the hopper 2 is filled with additional suspension in the period FG. In the period GH the sand of the suspension is allowed to settle, during which period no suspension is pumped into the hopper 2. At the point of time H the required sand volume V_{SH} is obtained.

In Figures 3 and 4 a floating suction dredger 11 for carrying out the method according to the invention is shown. This suction dredger is a trailing suction dredger having a hopper 12, a pump 10 connected to a trailing suction pipe 9 at its suction side and to a supply pipe 15 at its pressure side and having swingable draining-off syphons 16p and 16s forming draining-off means. Each draining-off syphon 16p and 16s comprises a fixed syphon pipe 41 connected to a pipe 20 and through a flexible conduit 42 to a movable syphon pipe 41 pivotably mounted at the syphon pipe 41. The movable syphon pipe 41 is operated by means of a hydraulic jack 17 and has an inlet nozzle 43. In the bottom of the hopper 12 sand outlets 18 are provided with discharge valves 19.

The hopper 12 could be divided into two longitudinal parts or the suction dredger could comprise two hoppers 12 arranged one behind the other.

The operation for loading this suction dredger 11 is as hereinafter described.

In a first loading step 13 (see Figures 2a and 2b) suspension sucked up through the suction pipe 9 is pumped by the pump 10 through the supply pipe 15 into the hopper 12 until the suction dredger 11 is loaded up to its maximum permissible loading capacity W_G .

The hopper 12 now contains sand and water of which sand of volume V_{SR} has been settled at the point of time B. The draining-off

syphons 16 now are still in the uppermost position corresponding to the volume V_{1B} .

In the subsequent second loading step 14 additional suspension is pumped into the hopper 12, and the draining-off syphons 16 are lowered into the hopper 12 to such depth, that sufficient liquid is drained-off through said draining-off syphons 16 and the pipes 20 connected thereto into the outboard water 21 to maintain the suction dredger loaded at its maximum permissible loading capacity. The draining-off syphons 16 are gradually lowered from the uppermost position corresponding to volume V_{1B} into a position corresponding to the volume V_{1C} .

Figures 2a and 2b clearly show that the total required loading time OC of the loading steps 13 and 14 of the method according to the invention is considerably less than the total required loading time OH of the known method, whereas the sand volume V_{SO} is about equal to the sand volume V_{SH} of Figure 1. The short loading time is a result of the second loading step 14, in which the suction dredger is continuously loaded up to its maximum permissible loading capacity. The total weight W_t is then continuously at the maximum W_G (see Figure 2b), whereas the total weight W_t in Figure 1b increases gradually during the second loading step 4, but is always under the maximum W_G .

The load is measured by means of pressure pick-ups 22_p, 22_c and 22_s arranged at the bottom of the suction dredger 11. Each pick-up comprises a pressure sensitive membrane 33 which forms a wall of a chamber 24 connected to the outboard water 21. Each pressure pick-up 22_p, 22_c and 22_s picks up the pressure corresponding to its depth in the outboard water, which is a measure of the draught at that part of the suction dredger 11 and hence the weight of the load. Nine pressure pick-ups 22_p, 22_c and 22_s are provided: to port, in the longitudinal centre plane and to starboard respectively as well as at the front, the rear and the mid part of the suction dredger.

Preferably throughout the second loading step 14 the volume of the hopper below the inlets of the draining syphons is adjusted automatically, for maintaining the suction dredger loaded at its maximum permissible loading capacity.

In Figure 5 an automatic control system for carrying out the method according to the invention is shown diagrammatically.

The pressure pick-ups 22_p, 22_c and 22_s provide signals to receivers 25_p, 25_c and 25_s respectively. From these signals, the draughts of the corresponding parts of the dredger are determined in calculating units 26_p, 26_c and 26_s. The outputs of these calculating units are provided to a draught list and trim calculating unit 27, providing signals to a draught indicator 28, trim indicator 29 and a safety

device 30. The calculating unit 26_s provides signals concerning the starboard draught to a comparing and calculating device 31_s, which in turn provides signals to a signal converter 32_s. The signal converter 32_s provide signals to control valves 33_s for controlling the hydraulic jack 17_s of the starboard draining-off syphon 16_s. The calculating unit 31_c provides signals concerning the central draught to both the signal converter 32_c and a signal converter 32_p, whereas a calculating unit 31_p in the same way provides signals to the signal converter 32_p and thus operates the jack 17_p of the port draining-off syphon 16_p by means of control valve 33_p.

As the calculating device 31_c provides like signals to both signal converters 32_p and 32_s, any list of the suction dredger owing to unequal loading may be corrected.

In case of an overloading and/or an inadmissible list, which is insufficiently corrected by the above-mentioned automatic control signals through the calculating devices 31_p, 31_c and 31_s, the safety device 30 provides signals to a visual alarm device 34 formed by a red light, to an acoustic alarm device 35 and to an automatic safety unit 36. The safety unit 36 provides signals for lowering the draining-off syphons 16_s and 16_p through the signal converters 32_s and 32_p, signals for putting the pump 10 out of action through a signal converter 37 and signals for opening the sand discharge valves 19 through a signal converter 38.

In order, however, to maintain the suction dredger 11 in operation when the automatic control system is out of order, the draining-off syphons 16_s and 16_p, the pump 10, and the discharge valves 19 may be controlled from an operating panel by hand through hand-operated members 40_p, 40_c and 39.

Owing to the use of a plurality of load-sensitive elements, formed by a plurality of pressure pick-ups 22, the lack of indication of the exceeding of the maximum permissible loading capacity is prevented.

When sucking up a suspension having a low proportion of sand, even though the hopper 12 which has a great volume, may be completely filled, the suction dredger may not yet be loaded up to its maximum permissible loading capacity. In this case suspension is still pumped into the hopper during a period in which the draining-off syphons are kept in their uppermost positions and in which water and possibly a little sand is drained-off over the upper edge 44 of the hopper 12. When the suction dredger is loaded up to its maximum permissible loading capacity in this way, additional suspension is pumped into the hopper 12 in the second loading step 14, in which water is drained-off by lowered draining-off syphons 16 which are adjusted in dependence on the pressure pick-ups 22 so that the suction dredger is maintained loaded

at its maximum permissible loading capacity.

At the end of the second loading step 14, the pump 10 is put out of action and the sand in the suspension standing above settled sand is allowed to settle in a subsequent period. At the end of this period the water standing above all the settled sand is drained off by lowering the draining-off syphons, to the surface of sand. In this way the suction dredger is loaded to below its maximum permissible loading capacity during the trip to the unloading place.

The suction dredger 11 preferably has a water pump 45 pumping up outboard water 21 through an inlet pipe 46 and connected by conduits 47 to jet-nozzles 48 mounted in the syphon pipes 41. These jet-nozzles function like jet pumps for starting the syphon operation of the draining-off syphons 16, when necessary.

It should be remarked, that at the point of time C when the pump 10 is put out of action, the trip to the unloading place can be started. In the subsequent period over the time CD, the sand in the suspension above the settled sand settles. At the point in time D, all liquid standing above settled sand is drained-off with the result that the suction dredger is loaded to below its maximum permissible loading capacity for the rest of the trip, so that it can travel at a greater speed.

If the level of the settled sand is lower than the water surface of the outboard water, the liquid above the settled sand may still be drained-off owing to the jet-nozzles 48 operating like jet pumps. After the draining-off operation the draining-off syphons are raised to their uppermost position.

WHAT WE CLAIM IS:—

1. A method of loading a hopper of a floating vessel with dredging spoil including a first step of supplying a suspension of the dredging spoil in water to the hopper until the vessel is loaded to a preselected weight and a second step of supplying additional suspension to the hopper whilst water in the hopper is drained-off by lowering draining means in the hopper in dependence on the weight of the load in the hopper so that the vessel is maintained loaded at substantially the preselected weight.

2. A method according to claim 1 in which the preselected weight is the maximum loading capacity of the vessel.

3. A method according to claim 1 or 2 in which the second step is performed until the vessel is loaded with sand substantially up to the preselected weight.

4. A method according to claim 1, 2 or 3 in which the suspension is sucked-out by means of a pump on the vessel.

5. A method according to any of claims 1 to 4 in which the first step includes supplying the suspension to the hopper until it is

completely filled and then continuing to supply the suspension whilst water is drained-off to maintain the hopper completely filled until the vessel is loaded to the preselected weight.

6. A method according to any of the preceding claims in which the draining means are maintained at their uppermost position throughout the first step.

7. A method according to any of the preceding claims in which the loading of the vessel is measured by sensing the pressure in the outboard water at a fixed position or positions on the vessel.

8. A method according to any of the preceding claims in which there are two such hoppers arranged one behind the other.

9. A method according to any of the preceding claims in which after completion of the second step the supplying of suspension to the hopper is stopped to allow the dredging spoil in the hopper to settle and then the draining means are lowered to the surface of the settled spoil to drain off the overlying water.

10. A floating vessel comprising a hopper with height-adjustable draining means, the height of the draining-means in the hopper being controlled by load-measuring means.

11. A vessel according to claim 10 in which a delivery pipe adapted to deliver a suspension of dredging spoil in water to the hopper is connected to the pressure side of a pump.

12. A vessel according to claim 11 in which the suction side of the pump is connected to a suction dredging pipe.

13. A vessel according to claim 10, 11 or 12, in which the volume of the hopper is so great that the vessel is loaded to its maximum loading capacity when the hopper is substantially completely filled with a suspension of dredging spoil in water.

14. A vessel according to claim 10, 11, 12 or 13 in which the draining means comprise at least one drain syphon having a height-adjustable inlet.

15. A vessel according to claim 10, 11, 12, 13 or 14 in which a safety device is controlled by the load measuring means and becomes operative, when the weight of the load of the hopper exceeds a predetermined value.

16. A vessel according to claim 15 in which the safety device when operative actuates means for lowering the level of the draining means.

17. A vessel according to claim 15 or 16 in which the safety device when operative actuates an alarm device.

18. A vessel according to claim 15, 16 or 17 in which the safety device when operative, puts the pump supplying the suspension to the hopper out of action.

19. A vessel according to claim 15, 16, 17 or 18 in which the safety device, when operative, puts in operation unloading means for

65

70

75

80

85

90

95

100

105

110

115

120

125



at its maximum permissible loading capacity.

- At the end of the second loading step 14, the pump 10 is put out of action and the sand in the suspension standing above settled sand is allowed to settle in a subsequent period. At the end of this period the water standing above all the settled sand is drained off by lowering the draining-off syphons, to the surface of sand. In this way the suction dredger is loaded to below its maximum permissible loading capacity during the trip to the unloading place.

- The suction dredger 11 preferably has a water pump 45 pumping up outboard water 21 through an inlet pipe 46 and connected by conduits 47 to jet-nozzles 48 mounted in the syphon pipes 41. These jet-nozzles function like jet pumps for starting the syphon operation of the draining-off syphons 16, when necessary.

- It should be remarked, that at the point of time C when the pump 10 is put out of action, the trip to the unloading place can be started. In the subsequent period over the time CD, the sand in the suspension above the settled sand settles. At the point in time D, all liquid standing above settled sand is drained-off with the result that the suction dredger is loaded to below its maximum permissible loading capacity for the rest of the trip, so that it can travel at a greater speed.

- If the level of the settled sand is lower than the water surface of the outboard water, the liquid above the settled sand may still be drained-off owing to the jet-nozzles 48 operating like jet pumps. After the draining-off operation the draining-off syphons are raised to their uppermost position.

WHAT WE CLAIM IS:—

1. A method of loading a hopper of a floating vessel with dredging spoil including a first step of supplying a suspension of the dredging spoil in water to the hopper until the vessel is loaded to a preselected weight and a second step of supplying additional suspension to the hopper whilst water in the hopper is drained-off by lowering draining means in the hopper in dependence on the weight of the load in the hopper so that the vessel is maintained loaded at substantially the preselected weight.

2. A method according to claim 1 in which the preselected weight is the maximum loading capacity of the vessel.

3. A method according to claim 1 or 2 in which the second step is performed until the vessel is loaded with sand substantially up to the preselected weight.

4. A method according to claim 1, 2 or 3 in which the suspension is sucked-out by means of a pump on the vessel.

5. A method according to any of claims 1 to 4 in which the first step includes supplying the suspension to the hopper until it is

completely filled and then continuing to supply the suspension whilst water is drained-off to maintain the hopper completely filled until the vessel is loaded to the preselected weight.

6. A method according to any of the preceding claims in which the draining means are maintained at their uppermost position throughout the first step.

7. A method according to any of the preceding claims in which the loading of the vessel is measured by sensing the pressure in the outboard water at a fixed position or positions on the vessel.

8. A method according to any of the preceding claims in which there are two such hoppers arranged one behind the other.

9. A method according to any of the preceding claims in which after completion of the second step the supplying of suspension to the hopper is stopped to allow the dredging spoil in the hopper to settle and then the draining means are lowered to the surface of the settled spoil to drain off the overlying water.

10. A floating vessel comprising a hopper with height-adjustable draining means, the height of the draining-means in the hopper being controlled by load-measuring means.

11. A vessel according to claim 10 in which a delivery pipe adapted to deliver a suspension of dredging spoil in water to the hopper is connected to the pressure side of a pump.

12. A vessel according to claim 11 in which the suction side of the pump is connected to a suction dredging pipe.

13. A vessel according to claim 10, 11 or 12, in which the volume of the hopper is so great that the vessel is loaded to its maximum loading capacity when the hopper is substantially completely filled with a suspension of dredging spoil in water.

14. A vessel according to claim 10, 11, 12 or 13 in which the draining means comprise at least one drain syphon having a height-adjustable inlet.

15. A vessel according to claim 10, 11, 12, 13 or 14 in which a safety device is controlled by the load measuring means and becomes operative, when the weight of the load of the hopper exceeds a predetermined value.

16. A vessel according to claim 15 in which the safety device when operative actuates means for lowering the level of the draining means.

17. A vessel according to claim 15 or 16 in which the safety device when operative actuates an alarm device.

18. A vessel according to claim 15, 16 or 17 in which the safety device when operative, puts the pump supplying the suspension to the hopper out of action.

19. A vessel according to claim 15, 16, 17 or 18 in which the safety device, when operative, puts in operation unloading means for



discharging dredging spoil from the hopper.

20. A vessel according to any of claims 10 to 19 in which the hopper is divided into two longitudinal parts.

5 21. A vessel according to any of claims 10 to 19 in which there are two such hoppers arranged one behind the other.

22. A method of loading a hopper of a floating suction dredger with sand, substantially as described and illustrated in the accompanying drawings.

10

23. A floating suction dredger substantially as described and illustrated in the accompanying drawings.

REDDIE & GROSE,
Agents for the Applicants,
6, Bream's Buildings,
London, E.C.4.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1972.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.