

REMOVING DREDGED MATERIAL FROM A CARGO SPACE

Technical field

The present invention relates to the field of dredging and land reclamation, and in particular relates to an arrangement for removing dredged material from a cargo space of a vessel, a converted vessel, and related method.

Background

In the dredging and land reclamation industry, the handling and transport of dredged material provides challenges. A typical operation may start by dredging material from the seabed and bringing the dredged material on board a vessel. The material may then commonly be transported to a desired destination and deposited, e.g. onto the seabed or shoreline, to build up the seabed or shoreline in that location for purposes of land reclamation.

It can be a significant challenge to carry out this process in a cost and time efficient manner.

Trailing suction hopper dredgers (TSHDs) are sometimes used to perform the actual dredging, transport, and unloading of the dredged material. The material may be transported and unloaded at a destination using equipment on board. If however material needs to be transported a substantial distance and the volume of material to be transported is large, such vessels may typically not be ideally suited as equipment may remain redundant for large periods of time. In such a vessel, unloading may be performed by releasing dredged material through hatches in the bases of the hoppers through the hull and onto the seabed at the required location. They can suffer from complexity in relation to the provision of base hatches.

Alternative solutions may therefore be preferable in which dredged material may be transferred from a dredger to another vessel such as a barge or a bulk carrier for transport of the dredged material onward to the desired destination. The dredged material may then be dewatered in order to meet classification requirements for "dry bulk" transport.

Once the destination location is reached, there is a need for unloading the dredged material in a swift and cost efficient manner. If the material has been transported in dry condition and/or if undergone some degree of compaction, unloading may be facilitated by adding water to the material

in the hold to fluidise the material so that material can be pumped out of the cargo hold as a slurry, i.e. as a fluid mixture of the dredged solids and injected water. In previous techniques, one approach for unloading material has been to deploy a centrifugal pump which is provided on a flexible hose and is lowered into the hold from above, onto the top of the material contained in the hold, to
5 apply suction for extracting material out the hold. However, in typical scenarios where the volume of material may occupy a hold dimension of for example 10 m x 20 m horizontally and the volume of material can have a typical height of more than 10 m, this approach can be inefficient, costly, and inconvenient to implement, as substantial lengths of hose pipe may be required to allow the pump to be moved to follow the material within the hold as the volume reduces in height during the
10 removal process, and to allow the pump to be moved laterally within the hold to extract remaining material. In addition, the hose may be moved between different holds so that it may service several of them.

An example of another kind of arrangement is shown in WO2011028129. In this arrangement, slurry or fluidised material is extracted in a fixed pipework system from near the base of a flat floored
15 cargo hold using a pump which is installed in an adjacent room. This overcomes some of the drawbacks of for instance the deployment of pumps on flexible hoses. For instance, the weight of the material in the hold can be used to help to drive slurry flow out of the hold near the base, rather than suctioning at the top. In addition, this arrangement can in general be well suited and convenient for operating centrifugal slurry pump machinery as may typically be applied in processing slurries in the dredging and land reclamation industry due to the substantial pumping power that such
20 machinery can provide. Such machinery can be usefully accessed in the adjacent hold of an arrangement such as proposed in WO2011028129 while unloading of the dredged material takes place..

However, the inventors have appreciated that in order to implement such an arrangement, pipe-
25 work may typically be required to penetrate through the bulkhead between adjacent holds, which may not always be desirable in light of constraints of certification, cost, and speed of outfitting (e.g. modifying a bulk carrier). In addition, difficulties can be encountered in removing material from a flat floor of cargo hold. With the slurry departing the cargo hold through a suction port at a fixed point near the base of the hold difficulties can be experienced as fluid can take irregular or unpredictable
30 paths over a flat floor, or take highly localised paths leading to the development of isolated mounds of material on the floor which can become stranded and may not be extractable by means of the pump. Moreover, the composition of the fluid slurry can change significantly as the dredged material depletes such that much more air is drawn into the pipework along with the flow of slurry out of the hold, presenting further challenges in how to handle and accommodate the
35 change in composition while still being able to pump slurry material effectively and efficiently out of the hold.

In this light, there remains a need for improved solutions, particularly in terms of cost and efficiency, for removing dredged material from holds or storage spaces on vessels.

The term “vessel” is used herein to include in particular ships such as bulk carriers or dredgers, barges, or other floating platforms. Such a barge may be a flat top barge or pontoon, a self-propelled, or a towed barge, and may be provided with one or more hoppers for storing dredged material. The bulk carrier may be an oil-bulk-ore carrier (OBO). The bulk carrier may be a “dry
5 bulk carrier”.

It is an aim of the invention to obviate or at least mitigate one or more drawbacks associated with prior art techniques.

Summary of the invention

According to a first aspect of the invention, there is provided an arrangement for removing dredged
10 material from at least one cargo space of a vessel, the arrangement comprising:
at least one channel arranged at a base of the cargo space;
pipework for removing the dredged material; and
at least one suction inlet, the suction inlet being operated by at least one operating device
in the cargo space to produce suction at the suction inlet, for allowing dredged material in the cargo
15 space to enter the suction inlet and to travel through at least one section of the pipework, for re-
moving the material from the cargo space.

The arrangement may comprise pipework for supplying a fluid, e.g. water, into the cargo space for
producing a slurry in the cargo space, the slurry comprising particles of dredged material. The
20 arrangement may further comprise at least one opening or nozzle, for outputting the supplied fluid,
e.g. water, from the pipework into the hold. In particular, the arrangement may comprise a plurality
of nozzles or openings arranged in the cargo space for delivering the fluid, e.g. water, out of the
pipework and into the cargo space for producing the slurry.

25 In general, the openings or nozzles may be arranged in any suitable pattern and/or in any location
in the cargo space. The arrangement and/or the vessel may be provided with at least one nozzle
for outputting a fluid, e.g. water, into the hold such that the fluid, e.g. water, mixes with particles of
the dredged material to produce the slurry, and any one or more of the nozzles may be arranged:
above the cargo space; near the base of the storage space; in the channel; and/or, on a crest or a
30 ridge between adjacent channels, the adjacent channels being arranged on the base of the storage
space.

The supplied fluid, e.g. water, to the cargo space may be jetted out of the openings or nozzles.
Accordingly, the fluid, e.g. water, may act on the dredged material to disturb and/or break up the
35 material to facilitate mixing. The supplied fluid, e.g. water, may saturate the volume of material in
the cargo space, e.g. by filling in and around the “pore” spaces between particles of dredged mate-
rial. The supplied fluid, e.g. water, may facilitate fluidisation and flow of the slurry containing parti-
cles of dredged material along the channel toward the suction inlet, e.g. “flushing” the channel.

Fluid, e.g. typically water may also be supplied to operate the operating device, in particular in embodiments in which the operating device comprises an ejector.

The fluid, e.g. water, may be supplied from equipment on a pump barge separate from the vessel
5 or from equipment on board the vessel.

Preferably, the operating device comprises an ejector, driven by a supply of drive fluid. The drive fluid may be or may comprise water. The arrangement may comprise pipework for supplying the drive fluid for the ejector. The drive fluid, e.g. the water, may be supplied from equipment on a
10 pump barge separate from the vessel or from equipment on board the vessel.

The ejector may typically comprise a venturi tube across which a flow is provided using the drive fluid for generating suction at the suction inlet, the dredged material, or in particular embodiments the slurry, being combined with drive fluid in the ejector such that the dredged material may travel
15 in the flow through the section of pipework for removing the dredged material from the cargo space.

The operating device may comprise a pump. The pump may comprise moving parts, e.g. may be a centrifugal pump.

20 Alternatively, the operating device, e.g. an ejector, may require no moving parts in order to operate.

The arrangement may further comprise a plurality of channels and at least one suction inlet for each channel.

25 The suction inlet may preferably be provided in fixed position within the cargo space. The suction inlet may preferably be aligned with the channel.

The pipework, and/or said section thereof, may preferably comprise fixed pipework. The operating device, suction inlet and/or a section of the pipework may accordingly be arranged below a top
30 level of the dredged material during removal, and the operating device, the suction inlet and /or the section of pipework may be arranged in fixed position. Thus, the operating device, the suction inlet and /or the section of pipework may remain in the fixed position during the removal process.

The suction inlet and/or operating device may, in use, be immersed in, surrounded by, and/or buried
35 by the dredged material contained in the cargo space during the removal of dredged material.

The water may be seawater. The vessel may be a bulk carrier. The vessel may be a barge, e.g. propelled or non-propelled, e.g. a flat top barge.

According to a second aspect of the invention, there is provided a vessel comprising at least one cargo space containing dredged material, the vessel being fitted with the arrangement according to the first aspect.

- 5 The vessel may comprise a plurality of cargo spaces, respectively fitted with said arrangement for removing the dredged material.

The vessel may be a converted vessel, e.g. chartered from a pool of available vessels for use on the open market, which then may be converted for performing an operation in which dredged material can be contained in a cargo space and be removable from the cargo space, the vessel being
10 converted by fitting said arrangement.

The vessel, prior to the conversion, may comprise pre-existing pipework for supplying a fluid, e.g. water, e.g. for supplying fire extinguishing nozzles or the like, the pre-existing pipework being utilised for supplying the fluid, e.g. water, into the hold for producing the slurry.
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The pre-existing pipework may be outfitted for supplying a fluid, e.g. water, e.g. seawater, into the cargo space, e.g. for activating the operating device and/or for delivery into the material to interact with the material for obtaining a slurry.
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The arrangement may be fitted without pipework penetrating a bulk head between adjacent cargo spaces of the vessel.

According to a third aspect of the invention, there is provided a method of converting a vessel by fitting the arrangement of the first aspect of the invention to the vessel.
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According to a fourth aspect of the invention, there is provided a method of removing dredged material from at least one cargo space of a vessel, the dredged material to be removed being contained in the cargo space, the method comprising the steps of:

- 30 providing a vessel fitted with the arrangement of the first aspect of the invention;
operating the operating device to produce suction at the suction inlet such that the dredged material enters the suction inlet and travels through at least one section of the pipework to remove the material from the cargo space.

35 The method may further comprise supplying a fluid, e.g. water or seawater into the hold to produce the slurry comprising dredged material.

The operating device may comprise an ejector operable by a drive fluid e.g. being or comprising water, wherein the method further comprises supplying the drive fluid into the cargo space. The drive fluid may be supplied through fixed pipework on the vessel. The drive fluid may be supplied
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using a pump on a pump barge through a drive fluid supply pipework on the vessel to the cargo space.

Any of the aspects of the invention may include the further features as described in relation to any other aspect, wherever described herein including the claims. Features described in one embodiment may be combined in other embodiments. For example, a selected feature from a first embodiment that is compatible with the arrangement in a second embodiment may be employed, e.g. as an additional, alternative or optional feature, e.g. inserted or exchanged for a similar or like feature, in the second embodiment to perform (in the second embodiment) in the same or corresponding manner as it does in the first embodiment.

Embodiments of the invention are advantageous in various ways as will be apparent from the specification throughout.

Description and drawings

There will now be described, by way of example only, embodiments of the invention with reference to the accompanying drawings in which:

- Figure 1 is side schematic view of a bulk carrier;
- Figure 2 is an end-on representation of a cargo hold of the bulk carrier of Figure 1 once converted with an arrangement for removing dredged material from the cargo hold, in close up, and according to an embodiment of the invention;
- Figure 3 is an elevated perspective representation of the arrangement of Figure 2 in close up;
- Figure 4 is a perspective representation of an open cargo hold of the bulk carrier once converted illustrating the arrangement of Figures 2 and 3;
- Figure 5 is a perspective representation of part of the hull of the bulk carrier of Figure 1 including a plurality of cargo holds with arrangement for removing dredged material from the respective holds, according to an embodiment of the invention;
- Figure 6 is a perspective representation of the cargo holds of Figure 5 from a different angle;
- Figure 7 is a perspective view in close up of a cargo hold of the bulk carrier with an arrangement for removing dredged material from the cargo hold with additional nozzles and supply pipework according to an embodiment; and

Figure 8 is an end on schematic representation of channel configurations in the cargo hold in various other embodiments.

Turning firstly to Figure 1, a vessel in the form of a bulk carrier 1 is illustrated. The bulk carrier 1 is one which may be available generally on the open market for sale or charter, in normal operational condition for transporting cargo across the sea, but which, as will be explained in the following, may be converted to provide specific functionality for use in dredging or land reclamation activities. Thus, in its normal condition it may typically have been used in other bulk cargo operations previously.

The bulk carrier 1 in this example has a number of cargo spaces in the form of cargo holds 2a-2g arranged in the hull along its length. Adjacent holds are separated by bulk heads. Each cargo hold 2a-2g (a "cargo space") provides an individual storage space for cargo and has a respective top hatch 3a-3g which may be opened to allow cargo to be inserted into the storage space of the hold, and closed, e.g. once the cargo holds are loaded, for transport. In this case, the cargo holds are to contain cargo in the form of dredged material including for example sand, silt, and other particles, etc., excavated from a seabed. The dredged material is referred to as "sand" in the following, for brevity and convenience.

With reference now to Figures 2 and 3, the cargo hold 2f is shown in further detail as an example, where the bulk carrier 1 is converted and fitted with apparatus including an arrangement 10, as is depicted generally, for removing sand contained in the hold 2f.

The arrangement 10 includes in this example three open-topped channels 12 on a base 4 of the hold 2f, and includes pipework comprising discharge pipes 14 for removing the sand. Close to the base 4, and aligned with each channel 12, a suction inlet 16 is provided. The suction inlet 16 provides a mouth, into which a slurry comprising fluid with particles of the dredged sand can enter from the channel 12 when the suction inlet 16 is operational to produce suction.

The arrangement 10 is further equipped with an operating device. The operating device is necessary for suction to be generated at the suction inlet 16. In this example, the operating device is in the form of an ejector 20, and one such ejector 20 is provided for each discharge pipe 14 for removing the sand. As is illustrated, the ejector 20 is disposed low down in the hold 2f, near the base 4. Thus, when the hold 2f is piled high with sand when loaded, the lower part of the discharge pipe 14, ejector 20, and corresponding suction mouth 16 are buried deep beneath the top of the sand pile. An example position of the upper level of sand contained in the hold 2f is illustrated in Figure 2, marked by a dashed line.

The ejector 20 includes a venturi tube 21 and operates to generate suction at the suction inlet 16 by driving a drive fluid in the form of water into the venturi tube 21. This generates a flow across a restriction in the venturi and a low pressure region is obtained adjacent to the restriction so that

sand and/or slurry comprising particles of the sand is suctioned from the suction inlet 16. The drive fluid is delivered to each ejector 20 through an ejector supply pipe 23 which penetrates downward to the location of the ejector 20 in the hold. At the ejector 20, the sand and/or the slurry containing particles of the sand from the suction inlet 16 combines with the drive fluid from the ejector supply pipe 23 and is driven together with the drive fluid in a combined flow upward through the discharge pipe 14 and out of the hold 2f. The pipework includes an external discharge pipe section 14e outside of the hold 2f for discharging the sand contained in the flow from the discharge pipe 14 off the bulk carrier, e.g. overboard and into the sea.

Although the above example describes the use of an ejector 20, in other embodiments, the operating device can be a pump such as a centrifugal pump or the like, placed in the hold 2f near the base 4 of the hold and adapted to be utilised in corresponding manner to the ejector 20 to generate suction at a suction inlet 16.

The arrangement 10 is also arranged to provide for fluidisation of the sand, to form a slurry containing the sand in the bottom of the channels 12 that can flow into the suction inlet 16 in use. To this end, the arrangement 10 is provided with slurry nozzles 31 for jetting a fluid, which in this example is water, into the sand at the base 4 of the hold 2f to produce the slurry. A nozzle supply pipe 32 is provided for each slurry nozzle 31, extending downwardly to the nozzle 31 at the base 4 of the hold, for supplying the water to the slurry nozzle 31. In Figure 3, the nozzle 31 and corresponding supply pipe 32 is omitted from the middle channel 12 in the drawing to allow the suction inlet 16 to be better visible (see Figure 2 where it is shown to be present).

Each channel 12 is arranged between channel sides which slope toward one another toward a bottom of the channel 12. Blocks 40 are arranged at the base of the hold for constructing the channel sides, providing the necessary topographic relief and slope at the base 4. Such blocks 40 may be constructed from aerated concrete, and/or other lightweight and high strength material for withstanding deformation from the weight of the sand above when sand is stored in the hold, either when dry or wet (e.g. when being fluidised to form a slurry). The blocks may be coated with a wear-resistant coating applied to the concrete, e.g. of polyurethane or other suitable material.

When sand is contained in the hold 2f up to the top level illustrated in Figure 2 with the dashed line the sand is also present throughout the length and width of the hold such that the parts of the arrangement 10 in the hold below the top level sand line are immersed in the volume of sand. These parts, including e.g. the ejectors 20, nozzles 31, suction inlets 16, and connecting sections of pipes, also remain in fixed position in the hold during the removal of the dredged material and depletion of the volume of sand within the hold.

Referring additionally to Figure 4, drive fluid in the form of water for driving the ejector 20 and for supplying water through the nozzles 31 is delivered from a water supply 50 through connecting pipes which connect the water supply 50 with the ejector supply pipes 23 and the nozzle supply

pipes 32. In other embodiments, separate water supplies may be employed for the delivery of water to the nozzles 31 and to the ejectors 20. A pump on a pump barge or on the vessel 1 may be used to drive water via the water supply 50 to the nozzles 31 and the ejectors 20.

In Figure 4, it can be seen that the water supply 50 is also arranged to supply water to a monitor nozzle 71 arranged above the opening to the hold 2f. The monitor nozzle 71 outputs water into the hold 2f at the top, to facilitate fluidisation and saturation of the sand in the hold 2f for removal through the suction inlet 16.

In Figures 5 and 6, the bulk carrier 1 has been converted so that each of the holds 2b to 2f is fitted with an arrangement 10 for removing sand in the same way as above described in relation to the hold 2f.

Although in the above examples a separate pipe is indicated from each hold for discharging the dredged material overboard, it will be appreciated that in other examples, the discharge pipes 14, 14e from each hold 2b-2f may lead to a manifold, where the flow containing the material from each hold 2b-2f is combined. From the manifold, the combined material may be discharged through a combined discharge pipe. This can be advantageous in terms of reducing pipework, and if the discharged material is to be transferred to another vessel, then the combined discharge pipe can provide a single point of offloading.

In Figure 7, the arrangement 10 in the hold 2f includes numerous nozzles 61 distributed along the channel near the bottom of the channel 12. The nozzles 61 provide outlet openings from second nozzle supply pipes 62 which are arranged along each channel, at the bottom of the channel 12. Fluid, in this case water, e.g. sea water, is supplied through the second nozzle supply pipes 62 and delivered, e.g. jetted with high velocity, into the cargo hold 2f through the nozzles 61, where the water combines with the dredged sand and produces a slurry in the channel 12 including particles of the dredged sand. The sand can thus be rendered flowable in a slurry so as to progress toward the suction inlet 16. Nozzles 31, 61, 71 of this kind, for delivering water into the hold into mixture with the dredged sand, may in general be placed in any suitable place in the hold 2f. In other variants, a nozzle supply pipe with further nozzles 61 for delivering water out of the pipe 62 into the holds may run along the crest of the channel 12, instead of or additionally to those nozzles 61 and second nozzle supply pipes 62 indicated in Figure 7. In addition, the nozzles 61 may in general point in different directions, e.g., up, down, and/or along the channel 12.

In converting the bulk carrier 1, the firewater system or other pre-existing water supply system and pipework, as may typically be provided on a standard bulk carrier for charter, is utilised to provide the water supply 50 for the slurry nozzles 31 and for driving the ejectors 20. The monitor nozzle 71 may accordingly be the monitor as provided normally for a firewater system for fire extinguishing purposes. In the conversion for use with dredged sand, the monitor nozzle 71 is utilised additionally for delivering water into the hold for producing a slurry containing particles of the sand for re-

removal. As part of the conversion, the channels 12 are formed on the base 4 by inserting appropriately shaped blocks 40 in the base 4 of the hold 2f to build sloping channel sides so that the slurry collects in the channels 12 to allow suction into the suction inlets 16 from fixed positions, aligned with the channel axes, in each hold. Fixed pipework is installed including the ejectors 20 and suction inlets 16, slurry nozzles 30 and the relevant supply and discharge pipework 14, 23, 32 in fixed position.

In use, when the holds 2b-2f of the converted bulk carrier 1 contain sand and it is sought to remove this from the hold for unloading, e.g. at a desired destination of the bulk carrier for land reclamation, the operating device is activated so that the suction inlets 14 generate suction in the channels to draw slurry containing sand in the channels into the inlet. The slurry is driven through the discharge pipes 14, upward out of an upper end of the hold (in a flow in combination with the drive fluid for the ejectors 20) and led off the bulk carrier for discharge, e.g. overboard into the sea. As the sand progressively is removed, the channels 12 facilitate collection and drainage of the sand in the channels 12 which can help to remove sand fully from the hold 2b-2f without leaving any significant amounts of sand behind. As a step prior or simultaneously to the removal of the sand, water is inserted into the hold 2b-2f, e.g. by operating the water supply, to saturate the sand with fluid (at least near the base of the stored volume of sand) for producing the slurry for fluidising the sand such that it can flow into the suction inlets 14 for removal.

Figure 8 provides examples of how the base 4 of the hold 2f may be arranged in other variants, with different channel geometries A-E. The channels of the respective geometries comprising valleys or troughs are denoted 716-716''' and ridges or crests are denoted 719-719''', formed by blocks on the base. As dredged material is drained from the cargo hold 2f through the suction inlet 16, the channels provide means by which the material being drained collects under gravity in the channel and is guided along the channel toward the outlet. The channels may be provided with wear-layers on the sides and bottoms of the valleys/troughs in the manner as indicated above. Other geometries are also possible for material to collect in channels or valleys. Typically, fluidising nozzles (not shown) are arranged near the ridges or crests 719-719''' and/or in the bottom of the channel valleys or troughs, for fluidising the dredged material and producing a slurry in the channel which is flowable to the suction inlet.

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The embodiments as described above may be advantageous particularly in that a bulk carrier may be converted and used for offloading sand efficiently and cost effectively. Ejectors can be disposed on fixed pipework in each hold, and be utilised to remove sand from the holds in parallel. The pipework can be constructed from readily available pipe sections and fittings in permanent location without need for repositioning. Ejectors can be cost effective in terms of construction, and may facilitate and low maintenance since the ejectors can activate by remote operation, e.g. simply by pumping in drive fluid from above the hold, and do not rely on moving mechanical parts. The

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channels on the base of the hold can allow the sand to be channelled appropriately to ensure or increase the effectiveness of the fixed position pipework in removing the sand from the holds.

Various modifications and improvements may be made without departing from the scope of the invention herein described.

CLAIMS

1. An arrangement for removing dredged material from at least one cargo space of a vessel, the arrangement comprising:
 - 5 at least one channel at a base of the cargo space;
 - pipework for removing the dredged material; and
 - at least one suction inlet, the suction inlet being operated by at least one operating device in the cargo space to produce suction at the suction inlet, for allowing dredged material in the cargo space to enter the suction inlet and travel through at least one section of the pipework, for removing the material from the cargo space.
2. An arrangement as claimed in claim 1, further comprising pipework for supplying water into the cargo space for producing a slurry in the cargo space, the slurry comprising particles of dredged material.
3. An arrangement as claimed in claim 2, further comprising a plurality of nozzles arranged in the cargo space for delivering the water out of the pipework and into the cargo space for producing the slurry.
4. An arrangement as claimed in claim 2 or 3, the vessel being provided with at least one nozzle for outputting water into the hold such that the water mixes with particles of the dredged material to produce the slurry, the nozzle being arranged in any one of: above the cargo space; near the base of the storage space; in the channel; or, on a crest or a ridge between adjacent channels, the adjacent channels being arranged on the base of the storage space.
5. An arrangement as claimed in any of claims 2 to 4, wherein the water is supplied from equipment on a pump barge separate from the vessel or from equipment on board the vessel.
6. An arrangement as claimed in any preceding claim, wherein the operating device comprises an ejector, which is driven by a supply of drive fluid comprising water.
7. An arrangement as claimed in claim 6, further comprising pipework for supplying the drive fluid for the ejector.
8. An arrangement as claimed in claim 6 or 7, wherein the water for the ejector is supplied from equipment on a pump barge separate from the vessel or from equipment on board the vessel.
9. An arrangement as claimed in claim 6 to 8, wherein the ejector comprises a venturi tube across which a flow is provided using the drive fluid for generating suction at the suction inlet, the dredged material being combined with drive fluid in the ejector such that the dredged material trav-

els in the flow through the section of pipework for removing the dredged material from the cargo space.

10. An arrangement as claimed in any preceding claim, wherein the operating device comprises a pump.

11. An arrangement as claimed in claim 10, wherein the pump is a centrifugal pump.

12. An arrangement as claimed in any of claims 1 to 10, wherein the operating device requires no moving parts in order to operate.

13. An arrangement as claimed in any preceding claim, further comprising a plurality of channels and at least one suction inlet for each channel.

14. An arrangement as claimed in any preceding claim, wherein the suction inlet is provided in fixed position within the cargo space.

15. An arrangement as claimed in any preceding claim, wherein the pipework comprises fixed pipework.

16. An arrangement as claimed in any preceding claim, wherein the suction inlet and/or operating device is buried within the dredged material contained in the cargo space during the removal of dredged material.

17. A vessel comprising at least one cargo space containing dredged material, the vessel fitted with the arrangement as claimed in any preceding claim.

18. A vessel comprising a plurality of cargo spaces, respectively fitted with said arrangement for removing the dredged material.

19. A vessel as claimed in claim 17 or 18, which is converted for performing an operation in which dredged material can be contained in a cargo space and is removable from the cargo space, the carrier being converted by fitting said arrangement.

20. A vessel as claimed in claim 19, which prior to conversion, comprises pre-existing pipework for supplying water, the pre-existing pipework being utilised for supplying water into the storage space for producing a slurry including particles of the dredged material.

21. A vessel as claimed in any of claims 17 to 20, wherein the arrangement is fitted without pipework penetrating a bulkhead between adjacent cargo spaces of the vessel.
22. A vessel as claimed any of claims 17 to 21, wherein the vessel is a dry bulk carrier or a flat
5 top barge.
23. A method of converting a vessel by fitting the arrangement of any of claims 1 to 16 to the vessel.
- 10 24. A method of removing dredged material from at least one cargo space of a vessel, the material to be removed being contained in the cargo space, the method comprising the steps of:
providing a vessel fitted with an arrangement as claimed in any of claims 1 to 16;
operating the operating device to produce suction at the suction inlet such that dredged material enters the suction inlet and travels through at least one section of the pipework to remove
15 the material from the cargo space.
25. A method as claimed in claim 24, which further comprises supplying water into the cargo space to produce the slurry comprising dredged material.
- 20 26. A method as claimed in claim 25 or 26, wherein the operating device comprises an ejector operable by a drive fluid comprising water, wherein the method further comprises supplying the water into the cargo space.
27. A method as claimed in claim 25 or 26, wherein the water is supplied through fixed pipe-
25 work on the vessel.
28. A method as claimed in any of claims 25 to 27, wherein the water is supplied using a pump on a pump barge connected to pre-existing water supply pipework on the vessel.