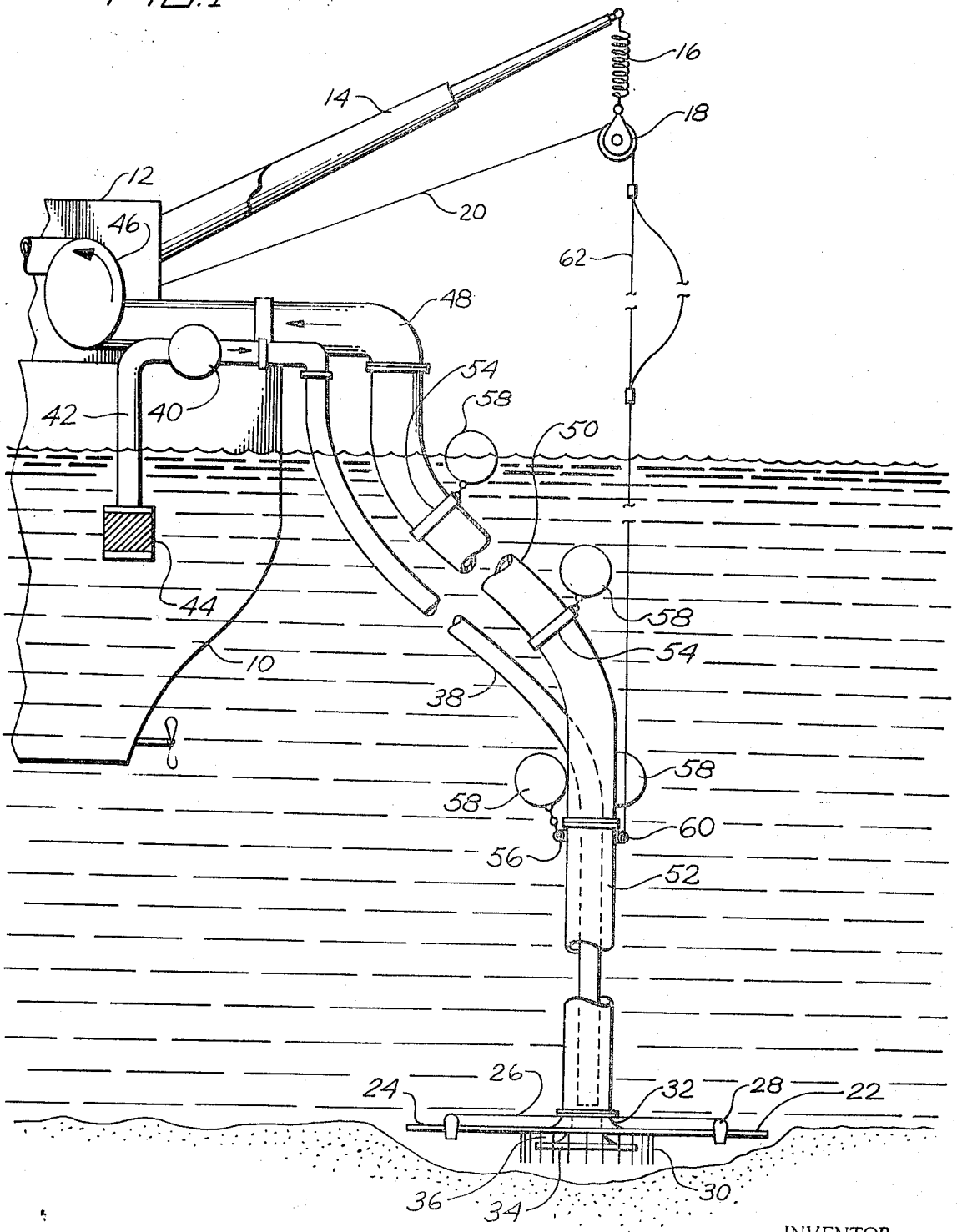
Dec. 1, 1970 N. B. PLUTCHAK 3,543,422

UNDERWATER MINING ASSEMBLY

Filed June 28, 1968 2 Sheets-Sheet 1

FIG. 1



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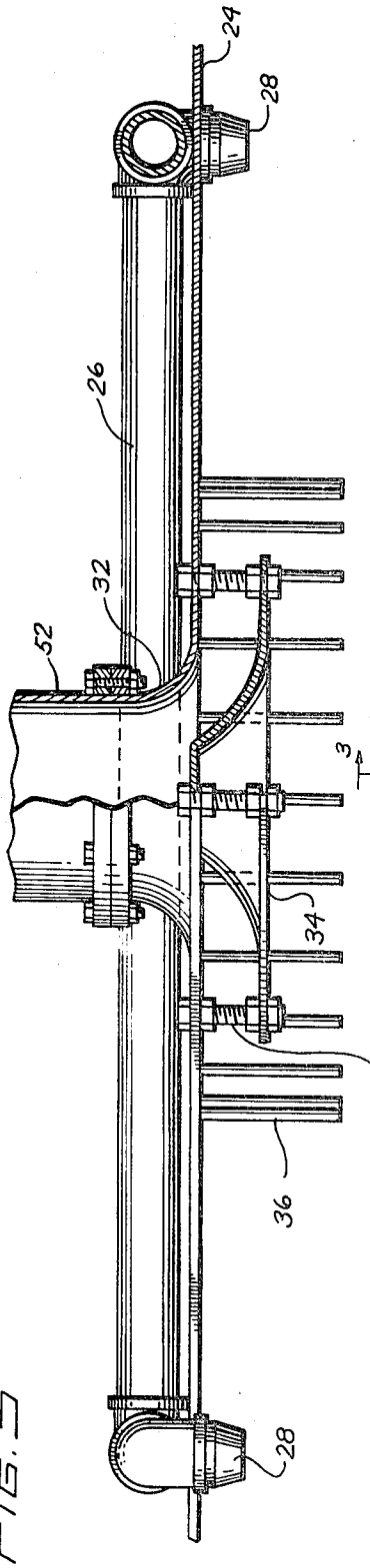


FIG. 3

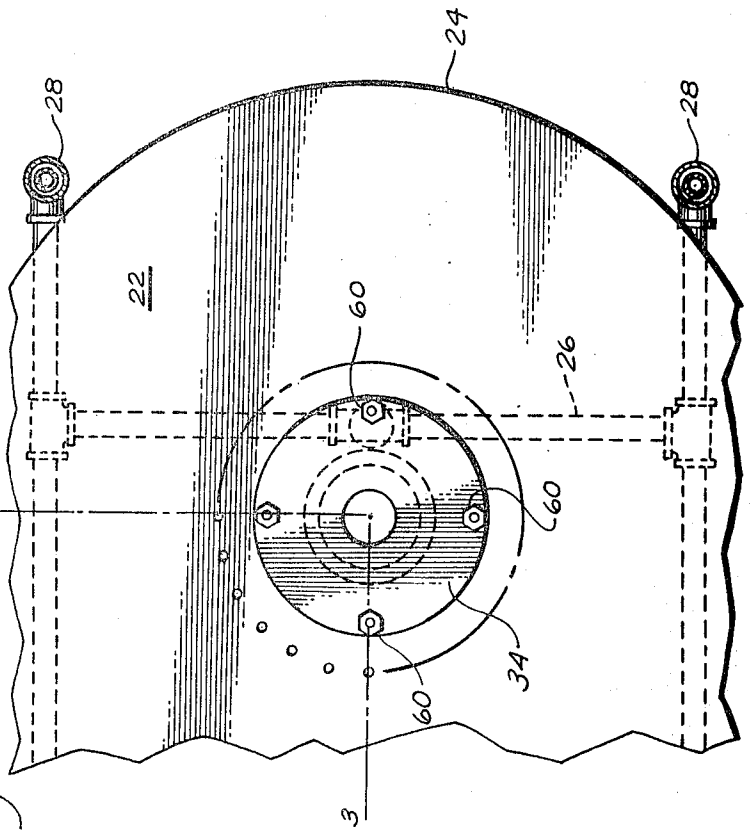


FIG. 2

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UNDERWATER MINING ASSEMBLY

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U.S. Cl. 37—57 10 Claims

ABSTRACT OF THE DISCLOSURE

A mining head having a flexible suspension arrangement for mining material from the bottom of the ocean or from any location where the material can be converted into a slurry. The head consists of a circular plate having a smoothly contoured circular passageway through its center connected with a large diameter hose and a bell-shaped member attached in close proximity to the central passageway to direct the flow into the hose. A manifold carries water at high pressure to a number of nozzles located around the edge of the plate, and flow from these nozzles puts the solids into suspension. The resulting slurry is drawn into the central passageway by means of a pump which carries the slurry to the desired location. The head is suspended from a crane carried on a ship by means of a cable having a flexible link to take up vertical movement due to wave action. Flotation buoys are fastened to the hose to keep the loaded hose essentially neutrally buoyant irrespective of its length or the weight of the slurry carried.

BACKGROUND OF THE INVENTION

There may be a number of reasons why one would want to remove material from the bottom of a body of water. In some cases, it is desired to simply clear a channel to provide adequate draft for boats or ships of a certain size. In this case there is no attempt to save the deposit nor to transport it other than to get it out of a particular location as efficiently as possible. This operation is understood as dredging and is different from mining, which is aimed at recovering the deposit with as little loss as possible and doing something to it or with it.

It is frequently desirable or necessary to remove sand from the bottom of the ocean either for the purpose of recovering some mineral found with the sand or for the purpose of putting the sand in another location. Great economic loss is sometimes caused by storms which make significant changes in the coast line, destroying or greatly diminishing sand beaches used for recreation. In such case it would be highly desirable to have an efficient means for transferring the sand from the bottom of the ocean near the shore line to the adjacent beach. While the need for more and more recreation area, it is also desired to move sand to form new beaches, to expand and improve existing ones, and to provide material for construction near the shore.

It has been found that conventional dredging apparatus is unsatisfactory in the above described operations because it is typically of a bulky and awkward design suited to lakes and harbors, but not to operation in the open sea. Dredging is normally viewed as a process for cutting into and removing deep continuous layers of unconsolidated to well-consolidated material. Because dredging is normally accomplished by means of a typical earth-moving bucket or "clamshell" or by an open-ended rigid suction pipe headed with a rotating cutter assembly, such apparatus is not adapted to working on small deposits or where the material to be removed is thinly spread over broad areas. Because of these inadequacies and the unavailability of any really satisfactory apparatus for mining sand in the open sea, the apparatus and system described herein were developed.

SUMMARY OF THE INVENTION

My invention includes a mining head of very efficient design and also connections to the head including a supporting structure and conduits for delivering water and recovering material, usually sand, in a slurry. The head includes a large disc or plate with a plurality of nozzles for directing water or other fluid at high pressure aimed downwardly at the periphery of the plate. Flow from these nozzles breaks the sand loose from its packed condition and converts the water and sand into a slurry which is confined below the plate member into a relatively restricted volume. At the same time, suction is produced at an intake at the center of the plate which draws the slurry into the intake and through a large diameter pipe or flexible hose to its desired location.

Since the sand is brought into and maintained in a state of suspension by the water jets directed into the surface, it is necessary to collect and transport this sand, and this is accomplished by creating a suction by means of a centrifugal pump at the head intake. This force must create sufficient velocity to keep as much as possible of the sand from settling out before it can be drawn into the intake port. To keep this velocity as high as possible over a significant area, a plate or disc is used which is kept essentially parallel to the bottom (where the bottom is essentially flat), this making the volume over which the suction force operates limited severely as to height, although of larger area. Thus a substantially two-dimensional velocity field is attained rather than a three-dimensionl velocity field, and the velocity falls off more nearly as the square root of the radius from the intake rather than as the cube root. As a result, the velocities maintained under the plate are sufficient, for the most part, to keep the sand in suspension even near the outside edge where velocities are lowest. This velocity must be redirected at the intake from horizontal to vertical movement, and this is accomplished with minimum loss by using a bell-shaped intake which minimizes turbulence in effecting the transition into the intake hose.

Because of the weight of the mining head and the large diameter hose carrying the slurry, flotation buoys are typically attached to the hose to keep the hose approximately neutrally buoyant, and the entire assembly to an effective negative buoyancy of only a few hundred pounds (typically 200–300 pounds). Although the mining apparatus might be located on shore, the usual installation is on a ship or large boat where complications are introduced because of the vertical movement resulting from wave action. The ship will normally carry pumps for pumping sea water into the smaller diameter hose to the nozzles and for creating the suction to pull the slurry into the large diameter hose and to transport it. These hoses are supported by means of a cable carried on a crane extending over the surface. To compensate for the vertical movement of the ship, this cable includes a section which is pulled slack and paralled by means of an accumulator, such as a flexible bungee member. The tension required to stretch the accumulator is somewhat less than the negative buoyance of the mining head assembly so that the head will remain close to the bottom surface despite the vertical movement of the ship.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view, partly broken away, of an underwater mining apparatus incorporating my invention;

FIG. 2 is a partial bottom view of the mining head of FIG. 1 with portions shown broken away, and

FIG. 3 is a side view, partially in section, of the mining head shown in FIGS 1 and 2, but drawn to a larger scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, the stern of a ship is shown at numeral **10** carrying a housing **12** from which extends a crane or boom **14**. Attached to the end of boom **14** is a spring **16** upon which is supported a pulley **18**. Also carried on the ship **10** is a quantity of cable, part of which is shown at numeral **20** and which is supported on pulley **18**. An underwater mining head is shown generally at numeral **22**, which head consists of a circular plate **24** which may be of substantial diameter, such as six feet, and a manifold **26** which supplies actuating fluid to a plurality of nozzles **28** which are preferably evenly spaced around the periphery of plate **24**. Attached to the bottom of plate **24** are a plurality of vertically extending rods **30** which form a protective screen for an inlet formed between a smoothly contoured opening **32** formed in the center of plate **24** and a bell-shaped member **34** spaced therefrom for defining an annular tapered opening **36**. Sea water or other operating fluid is supplied to the manifold **26** by means of a flexible hose **38** connected to a pump **40** carried on board the ship **10**. Pump **40**, in this instance, has an inlet conduit **42** extending below the surface of the water including a screen **44** through which is drawn sea water for the purpose of providing a working fluid under high pressure at the nozzles **28**. Also carried on board ship **10** is a centrifugal pump **46** which is connected to a conduit **48** having further connections with a large diameter flexible hose **50**. Hose **50** is fastened to a pipe **52** of comparable diameter extending vertically from mining head **22**. Carried on a number of collars **54** attached to the large diameter hose **50** and also to a plurality of lugs **56** attached to pipe **52** are a number of flotation buoys **58**. Attached to another lug **60** forming part of the pipe **52** is the end of cable **20** suspended from pulley **18**. Fastened into a length of cable **20** is a flexible accumulator which may be in the form of a stretchable or expandable bungee member **62** which carries a substantial portion of cable **20** in a slack condition, this portion being partially or wholly taken up as the bungee member **62** expands.

FIG. 2 is a bottom view, partially broken away, of the mining head **22** including the circular plate **24** and the bell-shaped inlet member **34** which is attached to the plate **24** by means of a plurality of bolts **60**. Two of the nozzles **28** are shown, along with a phantom view of the manifold structure **26** which supplies the working fluid to the nozzles.

FIG. 3 is a side view of the mining head **22** on an enlarged scale and with a portion shown in section, with the section as taken along line **3—3** of FIG. 2. This view shows the manner in which the bell-shaped inlet member **34** cooperates with the tapered inlet section of plate **24** to form a means of smoothly directing the flow of slurry from beneath the plate **24** up into the pipe **52**.

In operation from a ship such as that shown at numeral **10**, the mining head **22** is suspended as from a crane **14**, as shown in FIG. 1. The mining head **22** and pipe **52** are suspended from the cable **20** at a point relatively high on pipe **52**, as at lug **60**, such that the mining head will pivot from this point and continually seek a vertical orientation. As pump **40** operates to pull sea water from screen **44** into pipe **42** and from thence through the flexible hose **38** into manifold **28**, sea water is ejected under relatively high pressure from nozzles **28**. This imparts initial energy sufficient to break the packing state of the sand or the particles at the bottom and to get them into suspension to form a slurry. This volume of flow is not intended to move the material toward the intake. This action is provided by the suction from the large centrifugal pump **46** which, acting through the large diameter conduit **48**, the hose **50**, and the pipe **52**, causes a force pulling the slurry toward the intake between bell-shaped member **34** and the contoured section **32**. As the slurry is caused to flow upwardly through the flexible pipe **50**, the pipe is then caused to carry a substantial load, which increases the effective weight of pipe **50** considerably. For this reason, the collars **54** are supplied which carry flotation buoys **58**. The number of these collars, and the size and flotation force of the buoys required, is preferably chosen to keep the effective operating weight of the loaded conduit **50** approximately neutrally buoyant. With the conduit **50** held neutrally buoyant irrespective of its operating length, the forces carried by the cable **20** and which must be absorbed by the accumulator or bungee member **62** can be balanced against the effective weight in water of the mining head **22** so that the mining head is always carried in a substantially vertical position and such that wave motion causing vertical movement of the ship may be absorbed in the bungee member **62** and will not be translated to the mining head **22**. With the mining head suspended as shown, the center of gravity is sufficiently low that the mining head and pipe **52** together act as a pendulum such that the assembly can move around outcrops or large boulders, and the assembly continues to be oriented as shown so that it continues to strip off the deposit immediately under the plate **24**. The spring **16** is a safety device such that when the mining head **22** is being raised from the bottom or lowered to the bottom, no unnecessary high acceleration forces are applied to the system in the water. With the suspension arrangement as shown, the mining head remains on the bottom with the plate **24** essentially parallel to the bottom and only a short distance therefrom, so that the velocity forces of the slurry are kept sufficiently high to keep the sand or other bottom material in suspension until it can reach the intake structure **32, 34**.

While only one embodiment has been shown and described herein, modifications can be made within the scope of the present invention to meet the requirements of specific applications. For instance, the size of the parts, pipes, etc., and the sizes and capacities of the pumps **40** and **46** may vary with the grain size and density of the deposit which it is desired to recover. The force required from the nozzles **28** and the spacing in number of such nozzles may vary with the packing of the material which is being converted into a slurry. The depth of water from which it is desired to remove material will, of course, affect the length of hose and the suction pressure required which, in turn, also affects pump power and speed and whether to add or replace the pump with either a hydraulic or air lift system. Also, while the particular suspension system shown is simple and straight forward, modifications can be made, especially where larger forces are required. It may be that bungee member **62** would need, in some installations, to be replaced with a plurality of such members or with one or a plurality of springs. Other modifications will occur to those skilled in the art, and I do not wish to be limited to the present disclosure or otherwise than as defined by the scope of the following claims.

I claim:

1. Apparatus adapted to be carried on a vessel for mining material from the bottom of a body of water comprising:

a mining head adapted to be positioned near said bottom including a plate member maintained in a substantially horizontal position having a relatively large diameter tapered central passageway therethrough,

a bell-shaped member attached to said plate member and spaced from said tapered passageway to define a flow director of annular cross-section for directing the flow of said material into said central passageway, and

a plurality of substantially vertically directed nozzles arranged adjacent the periphery of said plate member and a manifold for directing flow to said nozzles;

means carried on said vessel for supporting said mining head including a crane and a pulley fastened to said crane,

a large diameter hose attached to said mining head adjacent said tapered passageway and pumping means for directing flow from said mining head to said vessel,

a smaller diameter hose attached to said manifold and pumping means for supplying fluid under pressure to said nozzles,

a cable extending from said supporting means through said pulley to said large diameter hose, said cable including a long-travel flexible accumulator section to permit said vessel to move vertically relative to said mining head.

2. Apparatus as set form in claim 1 wherein float means is attached to said large diameter hose.

3. Apparatus as set forth in claim 1 including screen members for keeping large objects out of said tapered passageway.

4. Apparatus as set forth in claim 1 wherein said plate member is substantially circular and said nozzles are substantially equally spaced around the periphery of said plate member.

5. Apparatus as set forth in claim 1 wherein said pulley is resiliently attached to said crane and the resilient attachment of said pulley to said crane requires substantially higher forces for a given deflection than does said flexible accumulator section.

6. For use with apparatus for mining material in a slurry, said apparatus including pumping means, a mining head adapted to be positioned near said slurry including a plate member maintained in a substantially horizontal position having a relatively large-diameter tapered central passageway therethrough,

a bell-shaped member attached to said plate member and spaced from said tapered passageway to define a flow director of annular cross-section for directing the flow of said material into said passageway, and

a plurality of substantially vertically directed nozzles arranged adjacent the periphery of said plate member and a manifold for directing flow to said nozzles; and

means for supporting said mining head in an essentially horizontal position including first conduit means for carrying fluid under pressure to said manifold and second conduit means for carrying said slurry from said central passageway to a desired location, said conduit means being connected with said pumping means.

7. Apparatus as set forth in claim 6 including screen members for keeping large objects out of said tapered passageway.

8. Apparatus as set forth in claim 6 wherein said plate member is substantially circular and said nozzles are substantially equally spaced around the periphery of said plate member.

9. Apparatus at set forth in claim 6 wherein said supporting means includes a cable attached to said second conduit means, said cable including a long-travel, relatively low-force accumulator device.

10. Apparatus as set forth in claim 9 wherein said cable is attached to said second conduit means at a significant height above said mining head such that said mining head is caused to seek its lowest possible position.

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37—63, 72; 254—135, 195