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[54] **APPARATUS FOR DREDGING IN DEEP OCEAN**

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[52] **U.S. Cl.** **37/61**, 37/65, 175/5

[51] **Int. Cl.** **E02f 3/88**

[58] **Field of Search** 37/58, 61–65; 417/108, 179; 175/5, 7, 10, 213; 299/9

[56] **References Cited**

UNITED STATES PATENTS

3,638,338	2/1972	Nelson	37/65
508,766	11/1893	Sackett	37/63
3,301,606	1/1967	Bruno	37/61 UX
842,364	1/1907	White	37/61
2,933,837	4/1960	Nelson	37/65
3,359,741	12/1967	Nelson	175/7 X
910,277	1/1909	Eliel et al.	37/61
1,690,239	11/1928	Nicol	37/61
1,530,654	3/1925	Daley	37/63 X
632,126	8/1899	Kirk	37/61 X

FOREIGN PATENTS OR APPLICATIONS

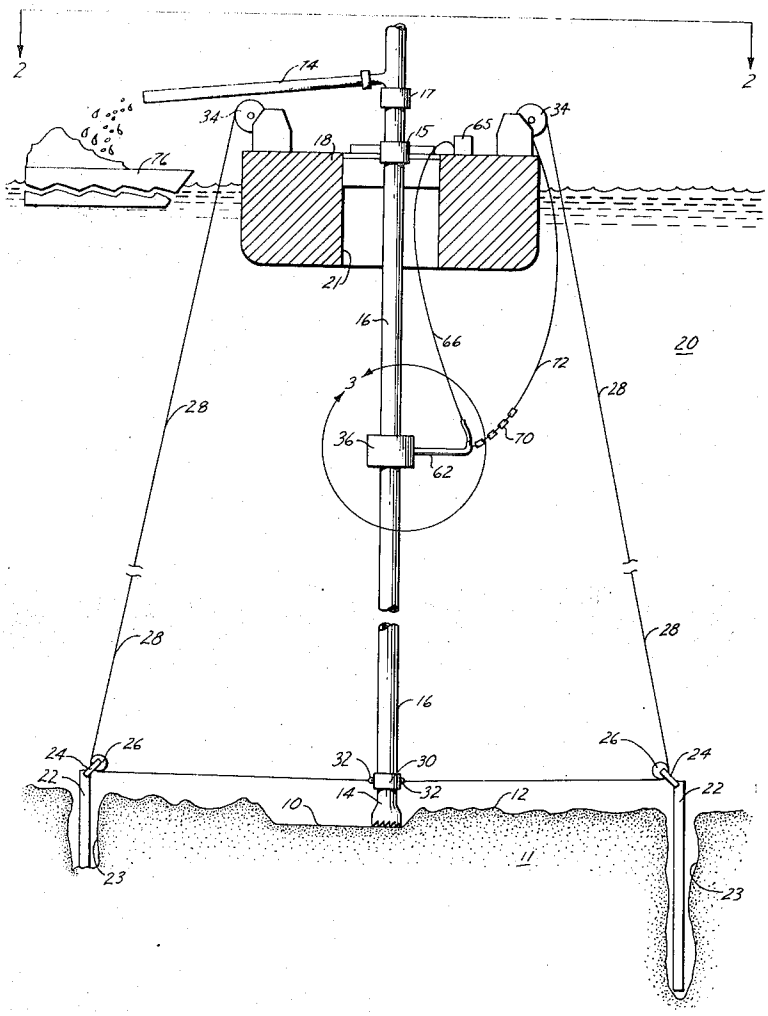
582,374	8/1933	Germany	37/64
697,492	10/1940	Germany	37/63

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[57] **ABSTRACT**

A surface stratum of an ocean bottom is dredged by a dredging tool connected to the lower end of an elongated hollow conduit pendulously supported from a floating vessel. A plurality of tool guiding lines extend from the vessel to the conduit via respective guides anchored at locations spaced about the region to be dredged. The effective lengths of the guide lines are adjusted from respective winches mounted on the vessel to sweep the dredging tool back and forth across the region to be dredged. The conduit is rotated about its vertical axis to operate the dredging tool, and an air lift sub injects a stream of air under pressure into the conduit above the dredging tool to lift the cuttings removed from the ocean bottom up through the hollow interior of the conduit.

8 Claims, 4 Drawing Figures



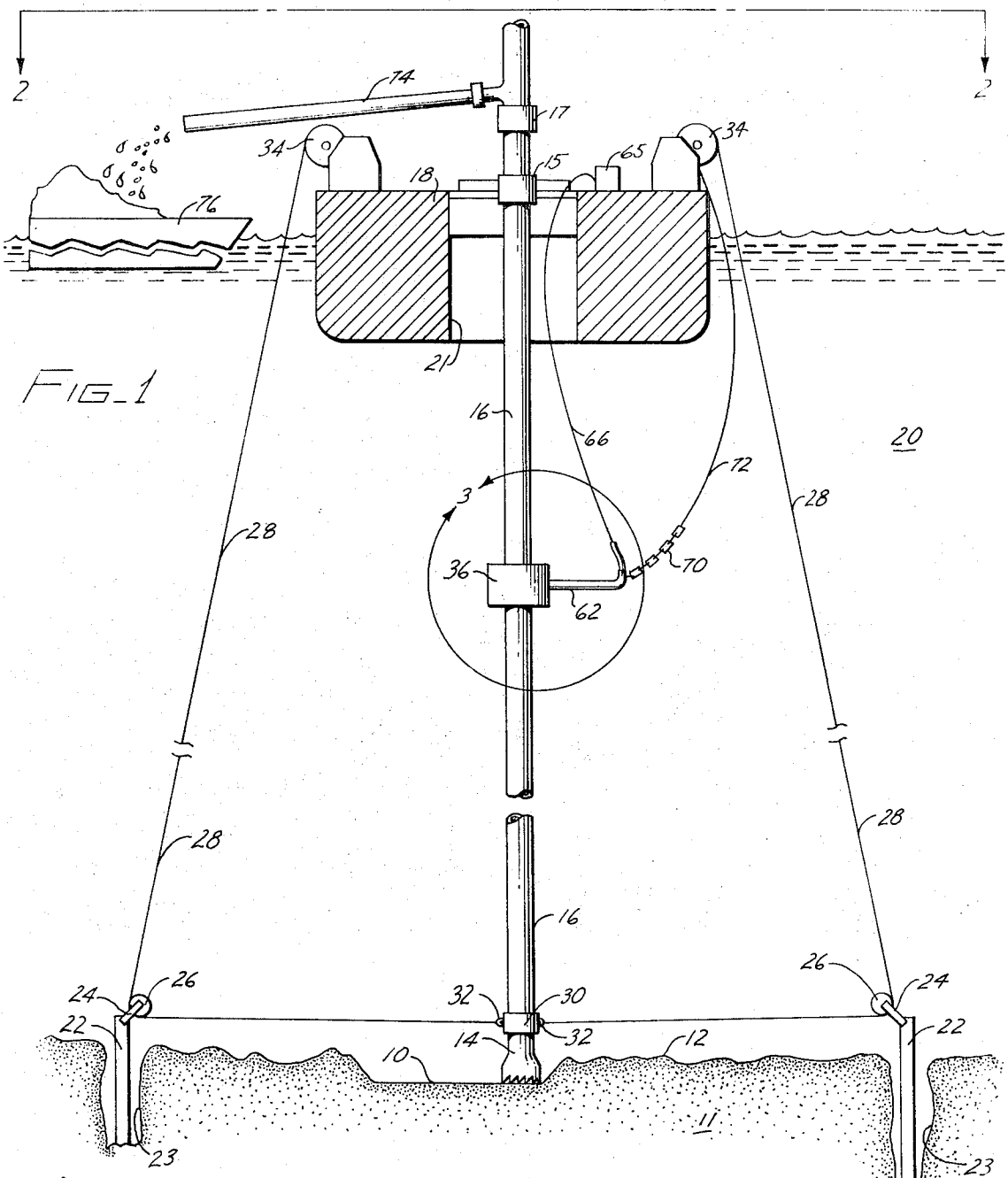


FIG_1

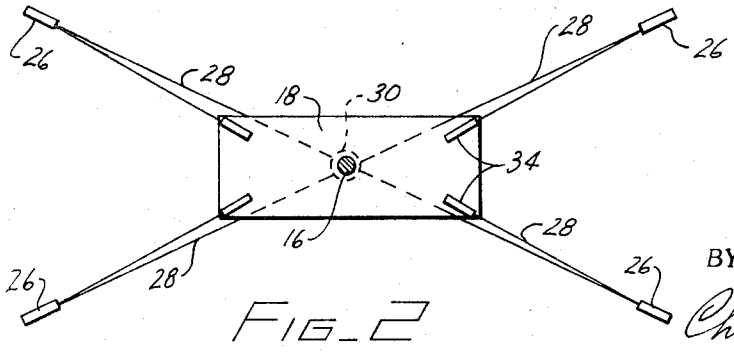


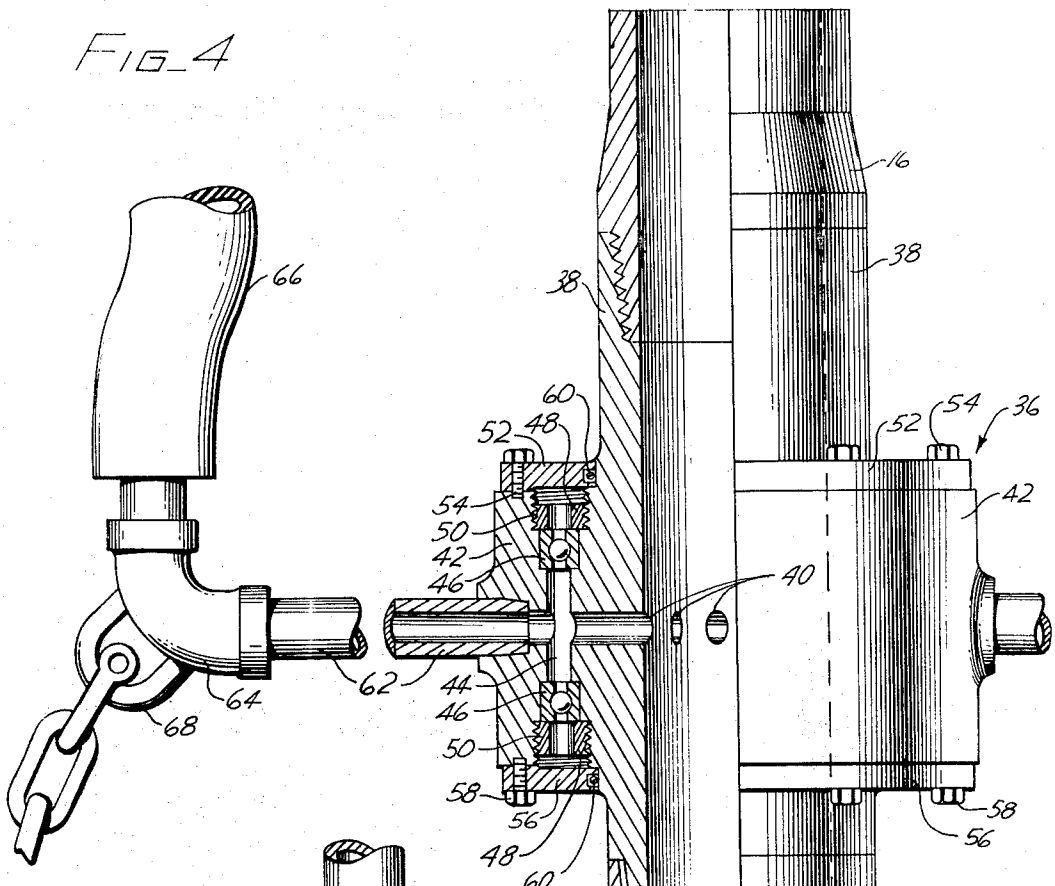
FIG_2

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FIG_4


16
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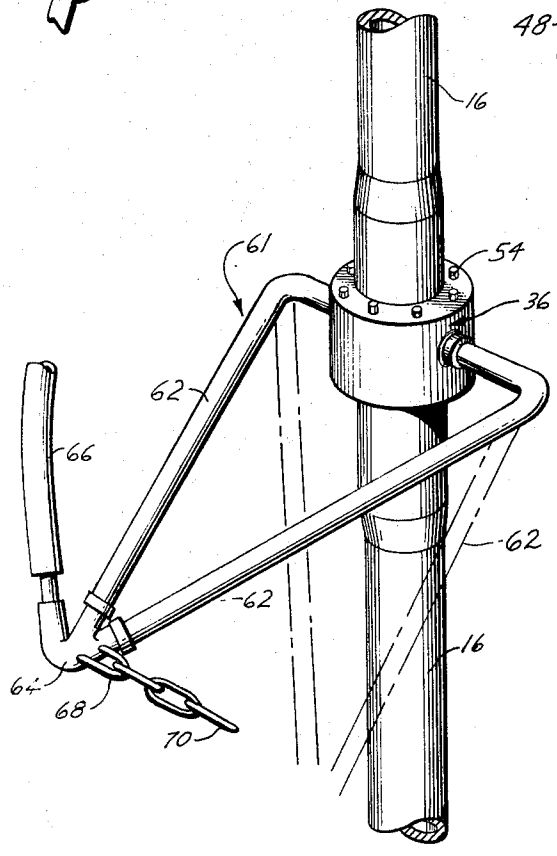

16
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FIG_3

APPARATUS FOR DREDGING IN DEEP OCEAN

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to dredging equipment, and more particularly to a system for dredging in deep water.

2. Description of the Prior Art

Prior art dredging equipment generally includes a barge which floats on the surface of a body of water and supports an elongated downwardly extending boom carrying a dredging tool, such as a rotary driven cutter head, at its bottom. The dredging tool is operated by mechanical and electrical power supplied from the barge. If it is desired to dredge in relatively deep water, a long and heavy boom is needed, but a massive boom carried by a barge can upset the balance of the barge. Moreover, the inertia of the long and heavy boom makes it difficult to effectively control the movements of the dredging tool from the barge, and the length of the boom poses problems in powering the dredging tool with mechanical and electrical power supplied from the remote barge.

Some prior art dredging systems include an elongated boom and dredging tool rigidly supported from a surface vessel, with tension lines running from the vessel, to the dredging tool, and then to an anchor at the dredging site. In these systems, dredging is carried on by taking in the tension lines to move the vessel and boom together relative to the channel bottom, with the dredging tool being driven as the vessel moves. These dredging systems would not be effective in deep water dredging of say 200 feet depths or more, because of the severe load which would be placed on the tension lines and related equipment which move the massive vessel and the long and heavy boom as an integrated unit.

SUMMARY OF THE INVENTION

This invention provides a system for dredging a surface stratum under deep water. The term "dredging" as used in this application refers to the removal of a surface stratum to modify the contour of it, or for the mining of the stratum, or for the removal of the stratum as overburden preparatory to mining an underlying stratum by appropriate techniques. A significant advantage of the present system is that it makes use of existing offshore well drilling vessels which are relatively simple in construction when compared with prior art dredging equipment, and which are operable by well known techniques and require a relatively minimum amount of modification to produce an effective means for dredging in deep water.

Briefly, the dredging system includes a vessel floating over a desired region of a surface stratum to be dredged. Preferably, the vessel is a ship of hull form, such as a conventional offshore drilling vessel. When drilling in ocean water, a vessel of hull form provides better stability and seakeeping characteristics than the prior art dredging barges which are practical for shallow water, but which are unsafe in ocean water because of their hull form and low freeboard. The surface stratum is engaged with a dredging tool connected to the lower end of an elongated conduit which is pendulously supported from the vessel. A plurality of tool guiding lines are connected from the vessel to the conduit adjacent the tool via respective locations spaced about the region to be dredged. The effective lengths of the guiding lines are adjusted to locate the tool at a desired position in the region to be dredged by displacing the tool relative to the vessel.

Preferably, the conduit may be a string of oilwell drill pipe coupled to a rotary table mounted on the vessel. The string of drill pipe has lateral flexibility and is therefore capable of covering a relatively large area of surface stratum in deep water even though the vessel remains relatively stationary. However, the conduit of this invention is not intended to be limited to a string of drill pipe. Dredging operations carried out in accordance with this invention may use a string of relatively thin-walled sections of pipe in place of oilwell drill pipe casing, because dredging operations do not subject the conduit to the high amounts of torque experienced when drilling an oilwell deep into a geologic formation. The lighter weight of a thin-walled pipe also adds to the flexibility of the conduit and makes it substantially easier to guide the dredging tool about the ocean bottom.

In a preferred form of the invention, the conduit is rotated about its length to rotate the dredging tool which excavates the surface of the desired underwater region. Preferably, the dredging tool is swept laterally back and forth across the underwater dredging site as the conduit is rotated by cooperatively taking in and paying out the guide lines which are strung from the vessel to opposite sides of the conduit adjacent the dredging tool via respective sheave blocks anchored at spaced apart locations on the ocean bottom.

The dredging tool is preferably in communication with the hollow interior of the conduit, and during dredging operations cuttings removed from the underwater dredging site are lifted upwardly through the interior of the conduit to the water surface where they are collected. The dredged material is preferably lifted upwardly through the conduit by an air lift mechanism in which a stream of air under pressure is injected into the conduit above the dredging tool to force the dredged material to flow upwardly through the conduit.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the invention are more fully set forth in the following detailed description of the embodiment of the invention which is presently preferred, such description being presented with reference to the accompanying drawings, in which:

FIG. 1 is a schematic fragmentary elevation view showing a dredging tool at the lower end of a conduit supported from a vessel floating above an underwater surface stratum being dredged;

FIG. 2 is a plan view taken on line 2—2 of FIG. 1;

FIG. 3 is a perspective view showing an air lift sub within the circle 3 of FIG. 1; and

FIG. 4 is a sectional elevation view of the air lift sub.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a region 10 of a surface stratum 11 of an ocean bottom 12 being dredged by a dredging tool 14 connected to the bottom of an upright, elongated hollow conduit 16 extending downwardly from a vessel 18 floating on a body of water 20 above the region being dredged. An upper section of conduit 16 extends through a well 21 which opens centrally through drilling vessel 18. A conventional rotary table 15 is mounted over the well in engagement with the conduit and operates to rotate conduit 16 about its vertical axis,

i.e., about its length. The upper end of conduit **16** terminates in a swivel assembly **17** above the rotary table.

Tubular steel piles **22** are anchored at points spaced about the periphery of the region to be dredged. The anchor piles may be set and cemented in the ocean bottom using the anchor piling system of A–Z International Tool Co. This system is described in the Composite Catalog of Oil Field Equipment and Services, published by World Oil, 1970–71 ed., Volume 1, page 171.

Alternatively, the piles **22** may be anchored by the following procedure. A conventional drilling vessel floating over the region to be dredged drops an expendable sonar beacon (not shown) to the ocean bottom. The vessel then receives the beacon signals by means of hull-mounted hydrophones (not shown). These signals are processed to assist in maintaining the position of the vessel over the dredging site. A jet sub (not shown) for steering the conduit **16** is connected to the lower end of the conduit. After sufficient sections of drill pipe casing are coupled together so that the lower end of the conduit formed thereby is in the vicinity of the ocean bottom, a sonar head (not shown) is inserted in the bore of the conduit and lowered to the bottom of the conduit. The sonar head is used to guide the conduit relative to the position of the sonar beacon, during which the conduit is propelled by the jet sub to a point at the corner of the region to be dredged, using the display of the sonar signal from the sonar head as a navigational aid. The sonar head is then drawn up through the conduit, and a hole **23** is drilled in the surface stratum **12** with a rotary drill bit (not shown) secured to the lower end of the conduit. One of the piles **22** is then set and cemented to the hole.

Additional piles **22** are cemented into the ocean bottom at points spaced about the periphery of the region to be dredged. As shown in FIG. **2**, four piles **22** preferably are anchored at the corners of a rectangular dredging region on the ocean bottom.

A sheave block **24** and sheave **26** are secured to the upper end of each anchor pile **22.** A separate wire rope or guiding line **28** is engaged with each sheave **26,** with one end of each wire rope being secured at the vessel and the other end temporarily secured to a respective buoy (not shown) anchored at some distance from the vessel.

After the piles **22** are anchored, conduit **16** is raised and the dredging cutter head **14** is coupled to its lower end. A collar **30** having four equally spaced padeyes **32** secured to its outer periphery is journalled to the lower end of the conduit above the dredging cutter head so that the conduit rotates relative to the collar. The four shipboard ends of the wire ropes **28** are then shackled to respective ones of the padeyes. The buoyed ends of the four wire ropes **28** are then brought to the vessel and connected to four respective winch drums **34** mounted on the vessel. Sections of the conduit are coupled together to lower the conduit, and the slack in the four wire ropes is taken up by the winches as the conduit is lowered.

During the lowering operations, an air injection air lift sub **36** is coupled to the conduit. Preferably, the air injection sub is positioned in the conduit to be located at an intermediate location between the vessel and the ocean bottom when the conduit is fully assembled.

The air injection sub **36** includes an elongated hollow inner barrel **38** coupled at its ends to conduit **16.** The inner barrel has substantially the same inside diameter and outside diameter as conduit **16,** and rotates with the conduit when the rotary table is operated. A plurality of laterally spaced apart air injection ports **40** extend through the side wall of the inner barrel and are disposed along a common circumferential line around the barrel. An annular outer barrel **42,** coaxial with the vertical axis of the conduit, surrounds the inner barrel **38** to define an annular air chamber **44** between the outer barrel and inner barrel. The outer barrel is mounted on the inner barrel by a pair of vertically spaced apart, upper and lower thrust and journal bearings **46** which permit relative rotation between the outer barrel and the inner barrel. A pair of upper and lower bearing retainer nuts **48** are threaded onto the outer surface of inner barrel **38** and tightened against the upper and lower thrust bearings, respectively, to maintain the inner portions of the bearings in a fixed position relative to the inner barrel. A second pair of upper and lower bearing retainer nuts **50** concentric to nuts **48** are threaded onto the inner surface of the outer barrel and tightened against the upper and lower thrust bearings, respectively, to maintain the outer portions of the bearings in a fixed position relative to the outer barrel. An annular upper seal plate **52** is fastened to the upper surface of the outer barrel by a plurality of bolts **54.** Similarly, an annular lower seal plate **56** is fastened to the lower surface of the outer barrel by a plurality of bolts **58.** The inner periphery of the upper and lower seal plates carries O-ring seals **60** which bear against the rotating outer surface of the inner barrel to provide a fluid-tight seal at both ends of the outer barrel so as to retain compressed gas in air chamber **44** and prevent sea water from entering the outer barrel.

An elongated tubular air supply and anti-rotation handle **61** includes a pair of outwardly extending and converging tubes **62** pivotally coupled to opposite sides of the outer barrel. The tubes open into opposing air passages through the side wall of the outer barrel to communicate with air chamber **44.** The converging ends of the tubes **62** are coupled to a bifurcated pipe fitting **64.** An air hose **66,** coupled to the other end of pipe fitting **64,** supplies compressed air or gas from a supply tank **65** on the vessel through the pipe fitting and the tubes **62** to the interior of chamber **44.** Pipe fitting **64** has a padeye **68** to secure a chain **70** which, in turn, is coupled to an elongated wire rope **72** running to the vessel, or to a sliding coupling with one of guide lines **28.** The wire rope **72** prevents rotation of the outer barrel when the conduct **16** is rotated, and prevents fouling of the air hose **66.** The air lift sub may include more than one pair of anti-rotation handles **61,** and each pair may be attached to a separate air hose, or anti-rotation chain, or both. The pivotal connection of the handle to outer barrel **42** permits tubes **62** to swing relative to the conduct (as shown in dashed lines in FIG. **3**) so the air lift sub **36** and tubes **62** may pass through drill well **21** as the conduit is lowered or raised through the well.

In use, dredging operations are carried on by rotating conduct **16** so as to drive the dredging cutter head **14.** The lower end of conduit **16** is swept laterally back and forth across the region to be dredged by operating winches **34** to cooperatively take in and pay out wire ropes **28.** The conduit **16** has substantial lateral flexibility because of its length to permit the cutter head **14** to reach a relatively large dredging area on the ocean bottom while the vessel **18** maintains a relatively fixed po-

sition at the ocean surface. Control thrusters (not shown) mounted on the vessel **18** or a conventional array of anchors (not shown) may be used to maintain the vessel in a fixed position over the dredging site.

Overburden removed from the ocean bottom by operation of the cutter head **14** is removed up the interior of the conduit **16** by the air injection sub **36.** Cuttings removed from the ocean bottom and sea water flow up the inside of the hollow conduit **16** with the high velocity flow induced in the conduit by the injection of an air stream into the sea water within the conduit by the air injection sub **36.** The air lift is constantly maintained during rotation of the conduit **16** and cutter head **14** by a supply of compressed air from air hose **66** which enters air chamber **44** and is injected into the interior of the conduit through air injection ports **40.** Cuttings rise in the interior of the conduit and are routed to an elongated spout **74** coupled to the upper end of the conduit above the deck of vessel **18** by swivel **17.** The cuttings are delivered by the spout **74** into a hopper barge **76** moored alongside vessel **18.**

Thus, this invention provides a system which is more suitable for dredging in deep water than prior art dredging systems. The floating vessel provides better stability than prior art dredging barges, particularly in ocean water. The conduit and means for driving the dredging tool at its bottom can be conventional offshore well drilling equipment. Such equipment is easily available and operable according to well known techniques. The conduit has lateral flexibility which permits dredging operations to be carried on while the vessel remains in a substantially fixed position. This feature has an advantage of permitting better maneuverability of the dredging tool than if the dredging system were arranged so the vessel and dredging tool move together during dredging operations. Moreover, the conduit may be extended from several hundred feet to several thousand feet in length without appreciably affecting the stability of the vessel. This is a substantial improvement over prior art dredging systems which, if modified to dredge in deep water of say greater than about 200 feet, would present critical problems and upset the balance of vessel stability.

I claim:

1. Apparatus for dredging a region of a surface stratum of an ocean bottom and the like comprising:

a. a floating vessel of ship-like hull form positioned over the desired region to be dredged, the vessel having a center well;

b. means disposed on the vessel above the center well for rotating a vertically disposed pipe string about its axis;

c. a vertically disposed pipe string coupled to the rotating means and extending pendulously from the vessel through the center well to a lower end adjacent the desired region, the pipe string being sufficiently long to manifest substantial lateral flexibility;

d. a dredging tool connected to the lower end of the pipe string and operative in response to rotation of the string about its axis to dredge the surface stratum in the desired region;

e. a plurality of line quiding means anchored independently of the vessel and the position thereof at selected locations spaced about the desired region;

f. a plurality of tool guiding lines extending from the vessel to locations on the conduit adjacent the tool via respective ones of the line guiding means;

g. means on the vessel for adjusting the effective lengths of the several guiding lines to displace the tool relative to the vessel to locate the tool at a desired position in the region; and

h. means coupled to the pipe string above the dredging tool for producing a suction effect at the dredging tool and for transporting dredgings upwardly through the pipe string.

2. Apparatus for dredging a region of a surface stratum of an ocean bottom and the like comprising:

a. a floating vessel positioned over the desired region to be dredged;

b. a vertically oriented elongated conduit pendulously supported from the vessel and extending through the water to the desired region, the conduit being supported so that a major portion thereof extends downwardly from the point of pendulous support to a point adjacent the lower end thereof independently of attachment to the vessel so the conduit is capable of free pendulous movement relative to the vessel in fore and aft and athwartships directions and combinations thereof;

c. a dredging tool supported on the lower end of the conduit and engaging the surface stratum in the desired region;

d. a plurality of line guiding means anchored in the stratum independently of the vessel and the position thereof at selected locations spaced about the desired region;

e. a plurality of tool guiding lines extending from the vessel to locations on the conduit adjacent the tool via respective ones of the line guiding means; and

f. means on the vessel for adjusting the effective lengths of the several guiding lines to displace the tool relative to the vessel to locate the tool at a desired position in the region.

3. Apparatus according to claim **2** wherein the conduit has lateral flexibility.

4. Apparatus according to claim **2** wherein each tool guiding line is connected to a winch mounted on the vessel.

5. Apparatus according to claim **2** including means for rotating the conduit about its vertical axis to rotate the dredging tool with it so the tool excavates material in the desired region as the conduit is displaced relative to the vessel.

6. Apparatus according to claim **5** including a collar disposed around the lower end of the conduit above the tool, means for mounting the collar to the conduit so the conduit rotates relative to the collar, and means for securing the end of each tool guiding line to the collar.

7. An air lift sub for use in lifting dredged material upwardly through the hollow interior of a pendulous rotary conduit comprising:

a. an inner barrel coupled to an intermediate portion of the conduit and rotatable with the conduit;

b. means forming a lateral fluid flow passage through the wall of the inner barrel;

c. an outer barrel outside the inner barrel, the outer and inner barrels defining an annular chamber between them;

d. means for coupling the outer barrel to the inner barrel so the inner barrel and conduit rotate relative to the outer barrel; and

e. means for supplying compressed gas under pressure to the annular chamber so the gas enters the hollow interior of the conduit through the fluid flow passage to produce an upwardly flowing stream that lifts the dredged material upwardly through the conduit.

8. Apparatus for dredging a region of surface stratum of an ocean bottom and the like comprising:

a. a floating vessel positioned over the desired region to be dredged;

b. an elongated conduit pendulously supported from the vessel and extending through the water to the desired region;

c. a dredging tool supported on the lower end of the conduit and engaging the surface stratum in the desired region, the tool being in communication with the hollow interior of the conduit;

d. a plurality of guide means anchored at respective locations spaced about the desired region;

e. a plurality of tool guiding lines extending from the vessel to the conduit via respective ones of the guide means;

f. means on the vessel for adjusting the effective lengths of the several guiding lines to displace the tool relative to the vessel to locate the tool at a desired position in the region; and

g. means for lifting dredged material from the desired region upwardly through the interior of the conduit by producing an upward flow of fluid within the conduit to force the dredged material to flow upwardly through the interior of the conduit, the lifting means further comprising an inner barrel coupled to an intermediate portion of the conduit and rotatable with the conduit, means forming a lateral fluid flow passage through the wall of the inner barrel, an outer barrel inside the inner barrel, the outer and inner barrels defining an annular chamber between them, means for coupling the outer barrel to the inner barrel so that the inner barrel and conduit rotate relative to the outer barrel, and means for supplying compressed gas under pressure to the annular chamber so the gas enters the hollow interior of the conduit through the fluid flow passage to produce an upwardly flowing stream that lifts the dredged material upwardly through the conduit.

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