United States Patent

Murray

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[54] **NODULE COLLECTOR**

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[73] Assignee: **Bethlehem Steel Corporation**

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[52] **U.S. Cl.** **299/8**

[51] **Int. Cl.** **E02f 7/00**

[58] **Field of Search** 299/8

[56] **References Cited**

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Primary Examiner—Ernest R. Purser

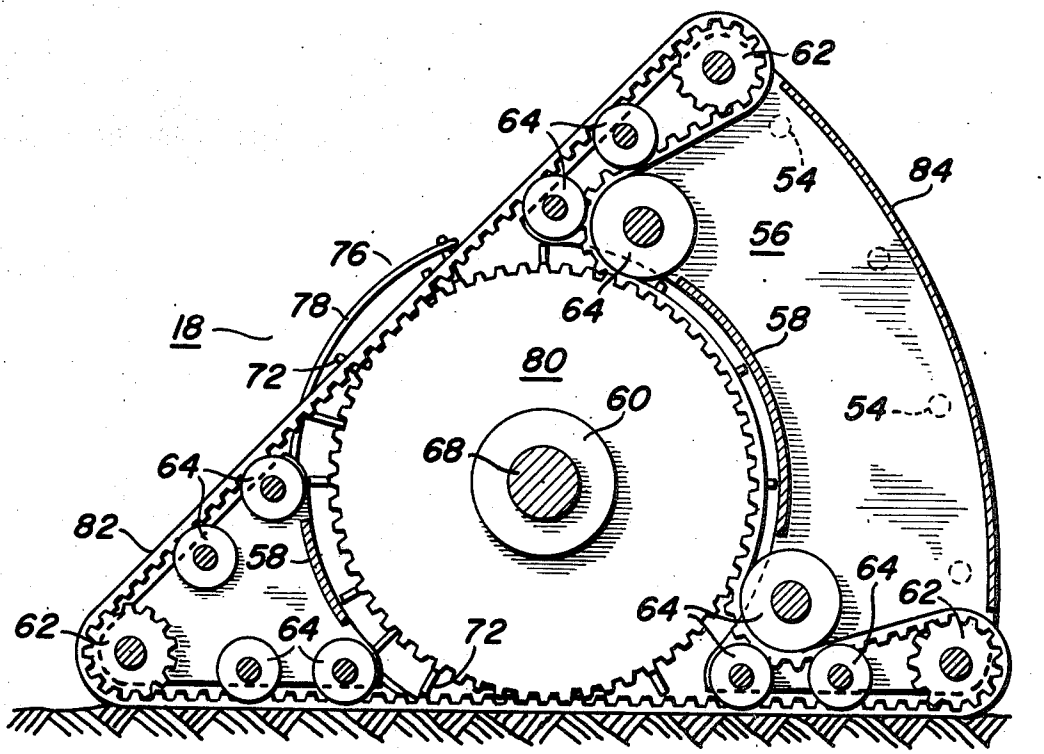
Attorney—Joseph J. O'Keefe

[57] **ABSTRACT**

A mechanical nodule collector is lowered to the ocean floor and towed along by a floating towing vessel. The towing means may be either a hoisting rope or a pipe through which collected nodules may be continuously pumped to a floating transport vessel. If the towing means is a pipe, the pipe is connected directly to a buoyant vessel, or pod, which is connected to the floating towing vessel and the floating transport vessel. The collector can be readily raised or lowered by varying the buoyancy.

The collector comprises a framework having a rotating paddle wheel attached thereto which penetrates the ocean bottom and sweeps nodules up a grating where they fall into a basket. The peripheral speed of the paddle wheel equals the peripheral speed of treads supporting the framework so that there is little or no relative motion between the tread and the ocean bottom, thereby minimizing disturbance of the bottom soil during the traversal thereof by the collector.

3 Claims, 12 Drawing Figures



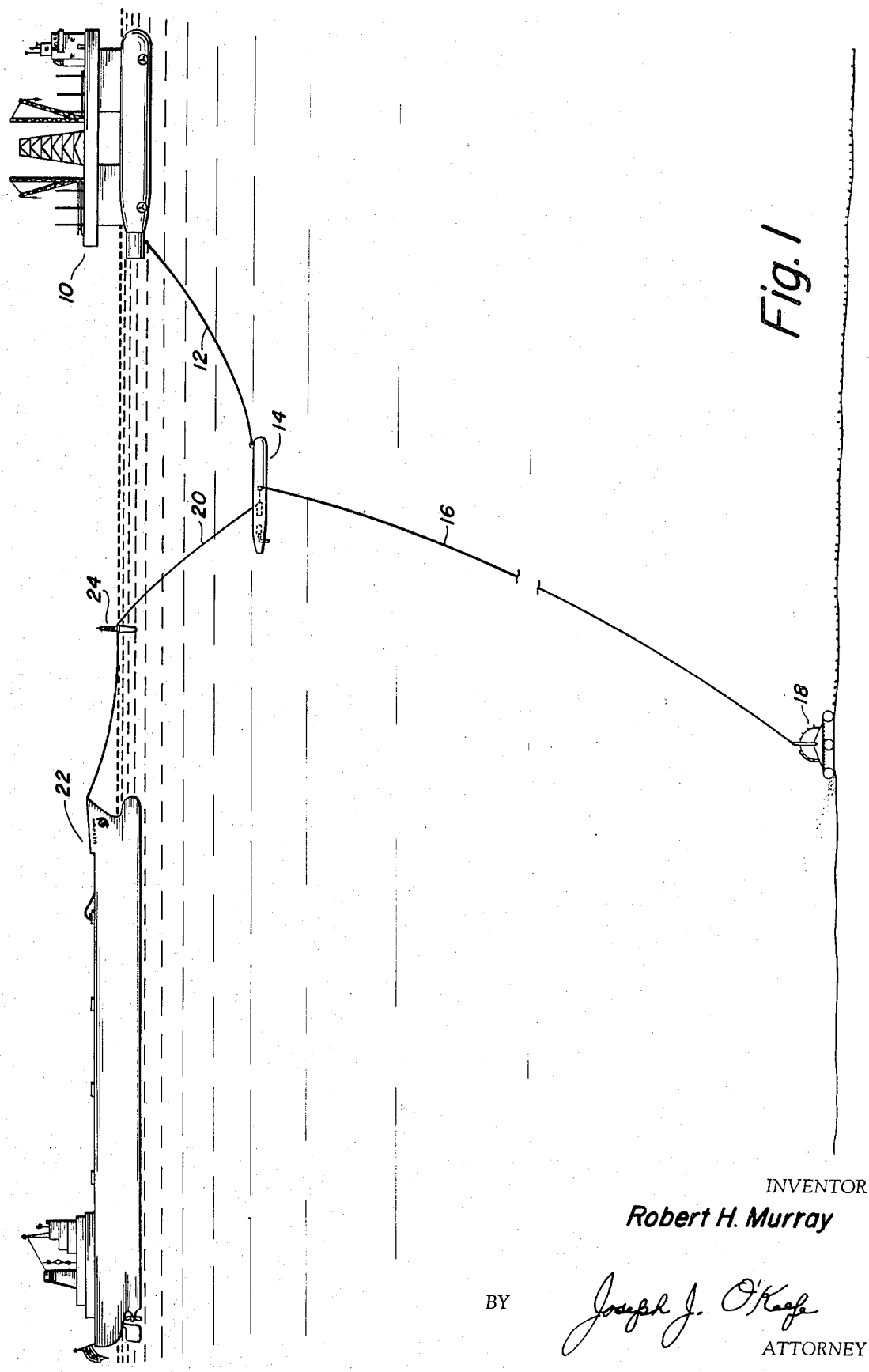


Fig. 1

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Fig. 2

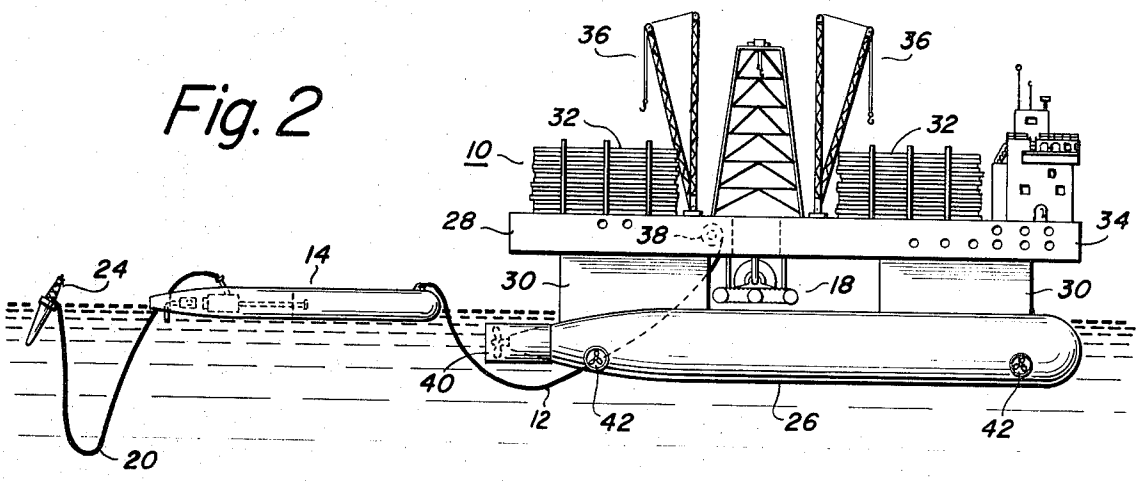


Fig. 4

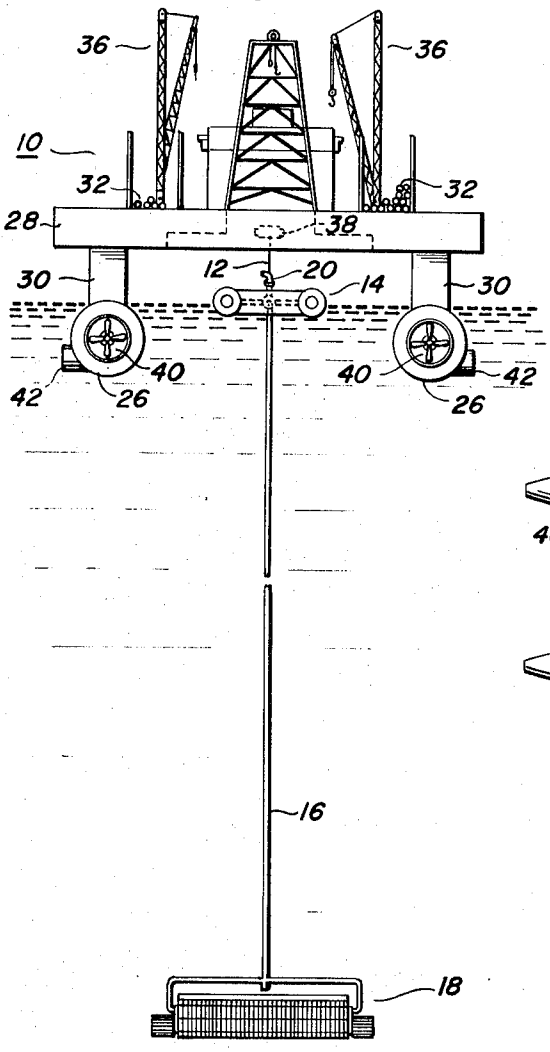
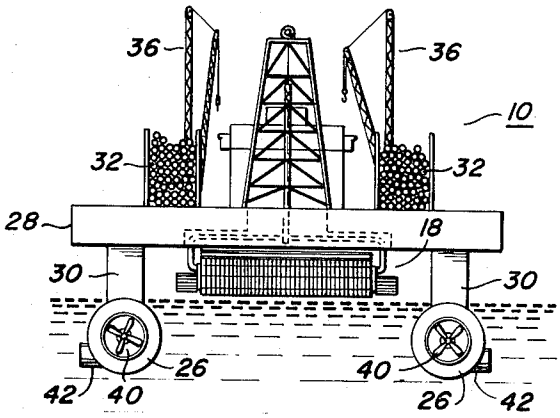


Fig. 3



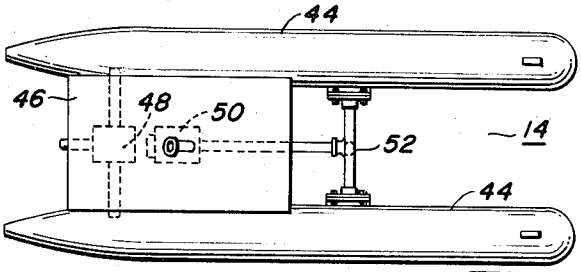


Fig. 5

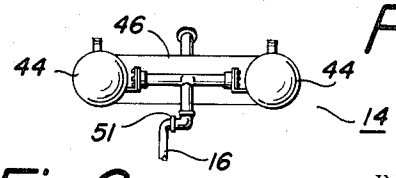


Fig. 6

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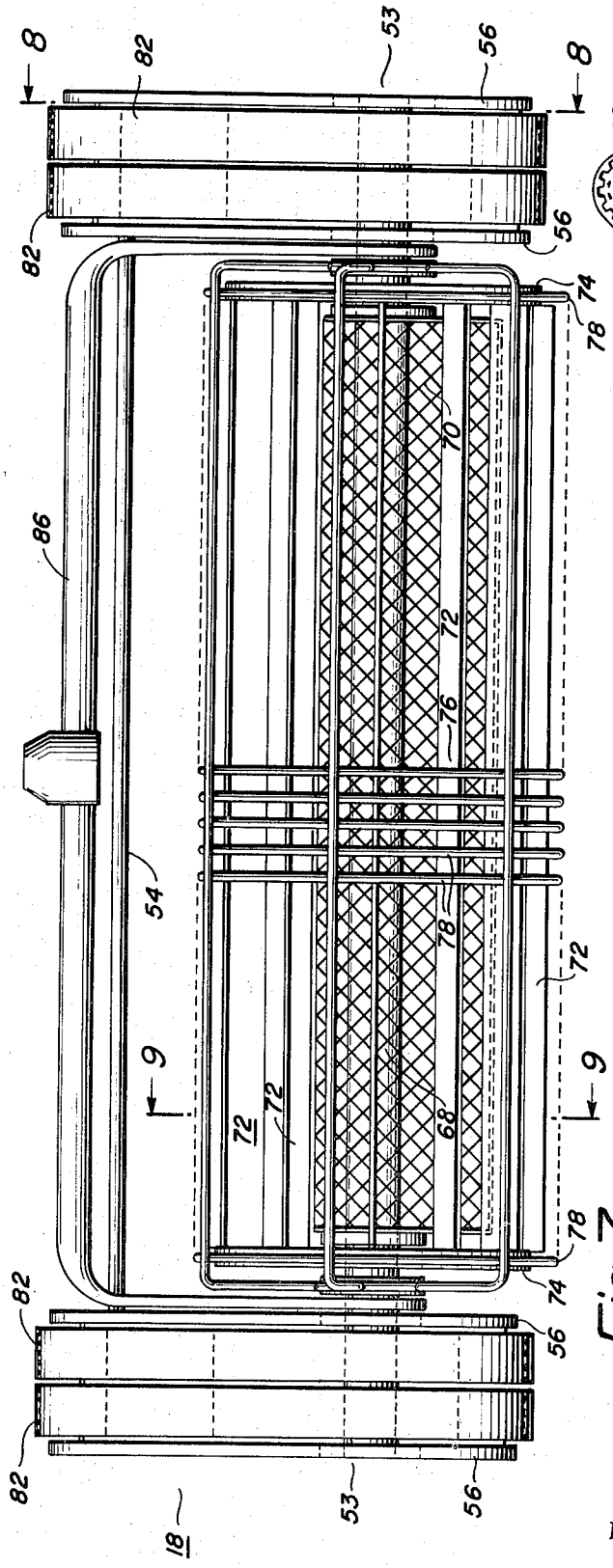


Fig. 7

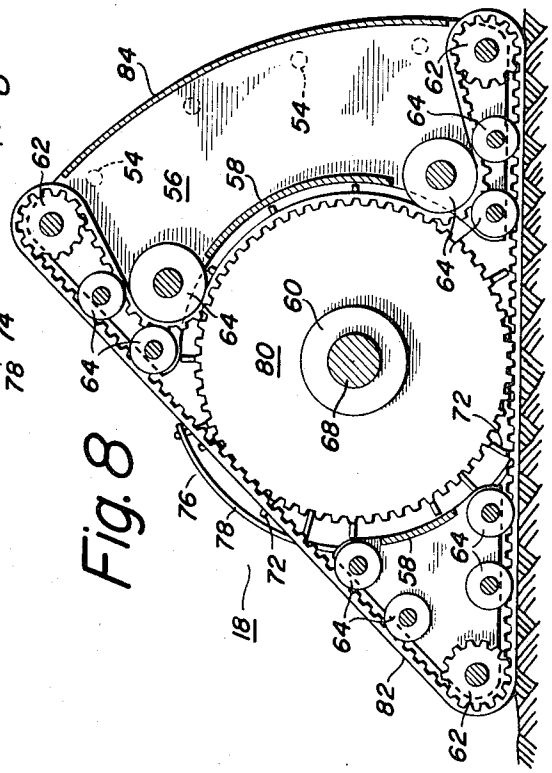


Fig. 8

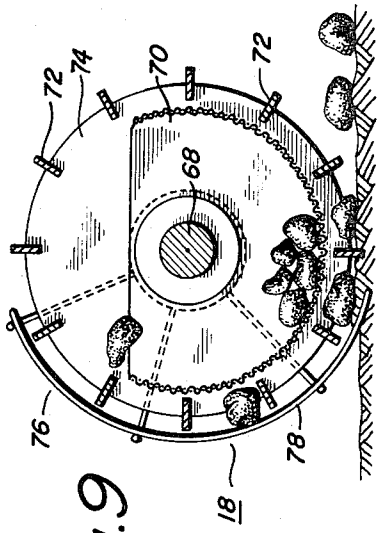


Fig. 9

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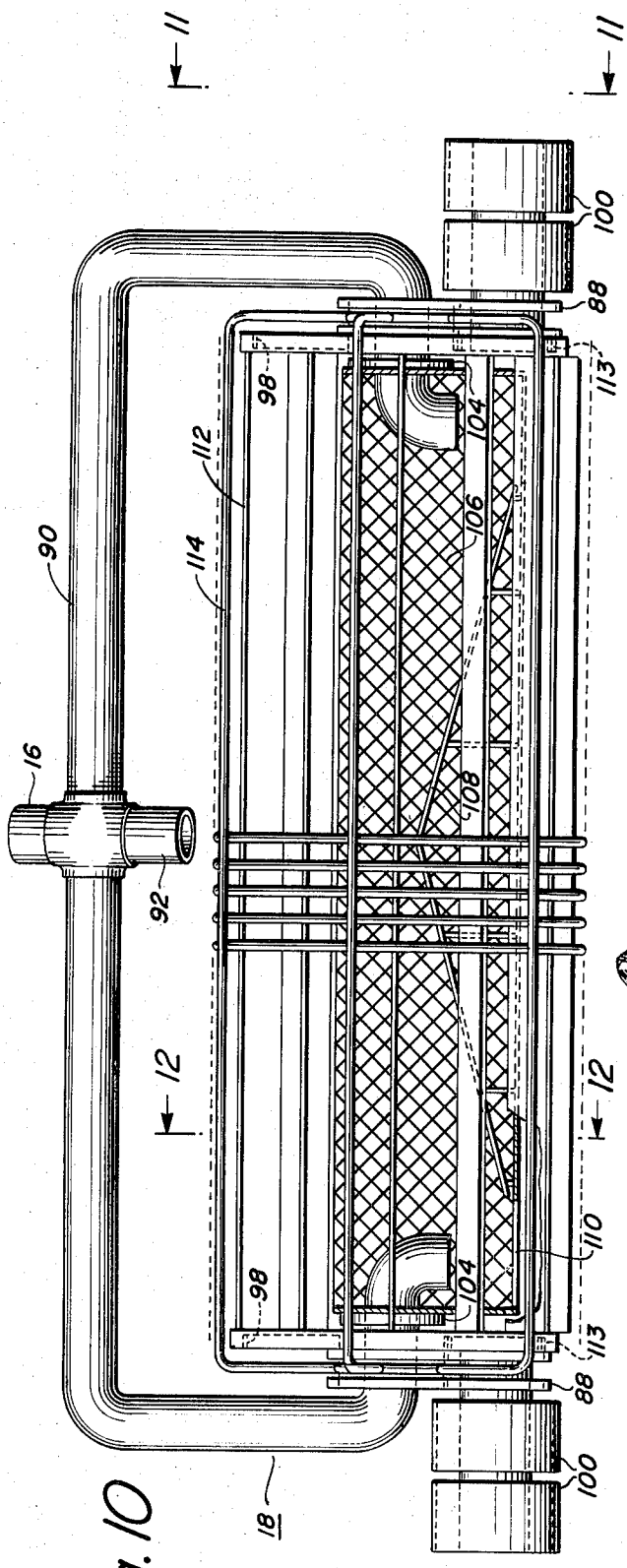


Fig. 10

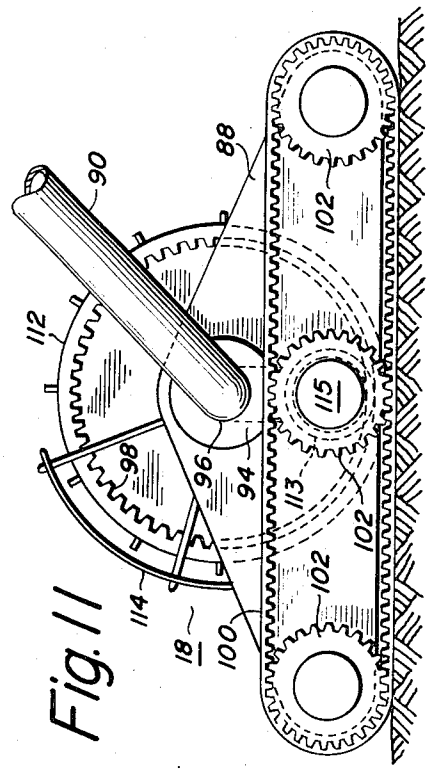


Fig. 11

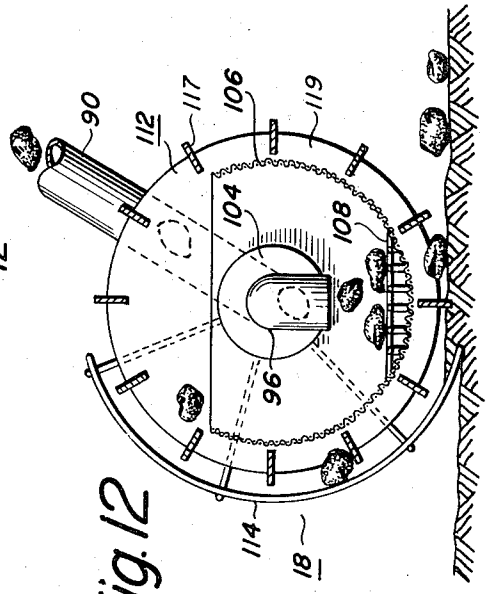


Fig. 12

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NODULE COLLECTOR

BACKGROUND OF THE INVENTION

This invention relates to a device for collecting solid material, either organic or inorganic, from the floor of a body of water.

In recent years, increased interest has been shown in tapping the ocean's resources. Of especial interest to many mining and metal-producing companies has been the harvesting of manganese nodules from the ocean floor.

While devices for collecting undersea nodules are broadly old, such prior art devices are characterized by one or more of the following basic problems:

1. They are unduly complicated and expensive, thereby making the mining operation prohibitively costly and risky and rendering the provision of a spare collector economically infeasible.

2. They cannot traverse soils having unfavorable characteristics without excessively disturbing the soil.

It is an object of this invention to provide a device which overcomes the above-described problems.

SUMMARY OF THE INVENTION

I have discovered that the foregoing object can be obtained by providing a collector comprising a framework supported on the ocean bottom by at least two treads. Rotatably attached to the framework, and adapted to receive nodules, is a basket. A paddle wheel, having its axis concentric with the axis of rotation of said basket, is rotatably connected to said framework, the inner edges of the paddle wheel blades being slightly spaced from the outer surface of said basket. The paddle wheel is connected, by gears, for example, to tread-driving means so that the peripheral speed of the paddle wheel blades is equal to the peripheral speed of the treads. This connection results in very little disturbance of the ocean bottom during the collecting operation. A grillwork, extending from a point substantially directly under the paddle wheel axis to a point higher than said axis and rearwardly thereof, is disposed in close proximity to the periphery of said paddle wheel. Nodules are swept us said grillwork and subsequently slide across the blades and drop into the basket.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view of a nodule collecting system.

FIG. 2 is an enlarged side elevation of the towing vessel shown in FIG. 1.

FIGS. 3 and 4 are end elevations of the towing vessel showing the collector in its raised and lowered positions, respectively.

FIG. 5 is a plan view of the submersible vessel.

FIG. 6 is an end elevation of the vessel shown in FIG. 5.

FIG. 7 is a rear elevation of a batch type collector.

FIGS. 8 and 9 are sectional views taken along the lines 8—8 and 9—9, respectively, of FIG. 7.

FIG. 10 is a rear elevation of a continuous type collector.

FIGS. 11 and 12 are sectional views taken along the lines 11—11 and 12—12, respectively, of FIG. 10.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, the subject apparatus broadly comprises a towing vessel 10 connected by a tow-power cable 12 to a submersible vessel, or pod 14. The pod 14 is connected by a riser pipe 16 to a collector 18. The pod is connected by a discharge pipe 20 to a transport vessel 22. For reasons to be described later, the pipe 20 is attached to a buoy 24 intermediate the pod 14 and the transport vessel 22.

As shown in greater detail in FIGS. 2–4, the towing vessel 10 is a catamaran comprising twin hulls 26 supporting a platform 28 by means of supporting structures 30. Stacked on the platform 28 is a plurality of sections 32 of riser pipe 16. Each section may be, for example, about 32 inches in diameter and eighty to one hundred feet long. Integral flanges are provided at each end of each section to provide for bolted connections.

The platform 28 is provided with crew quarters 34. Also provided are cranes 36 for lifting the pipe sections 32 off the stacks and into position for attachment. A winch 38, for towing the pod 14 is mounted on the platform.

The twin hulls 26 are provided with screws 40 as well as bow and stern thrusters 42 for effective maneuverability at low speeds. The collector 18 is initially docked between the twin hulls 26.

The pod 14, shown in detail in FIGS. 5 and 6, comprises interconnected twin hulls 44. Said hulls may be interconnected by either a flooded or a sealed compartment 46. Means, e.g. a pump or a compressor, is provided for varying the buoyancy of said pod. If the compartment 46 is sealed, for example, a pump 48 may be housed therein which is adapted to pump sea water into and out of the hulls 44 and the compartment 46, thereby varying the buoyancy of the pod 14. If a compressor is used, the compartment 46 may be initially charged with air under pressure to provide a reservoir of air which may be used to displace sea water, and the tow-power cable 12 may be provided with an air hose to replenish this reservoir with air from a compressor mounted on the vessel 10. Power is supplied to the pump 48 through the tow-power cable 12.

The pod is also provided with a pump 50 for pumping nodules collected by the collector 18 to the transport vessel 22. As shown in FIG. 6, a section of riser pipe 16 is connected to a swivel joint 51, which is in turn connected to a T-section 52 of pipe leading to the inlet of the pump 50. A section of discharge pipe 20 is connected to the outlet of the pump 50.

The collector 18 may be either of the batch type or the continuous type. By "batch type" is meant that no means is provided for removing nodules from the collector during the collecting operation. Nodules are removed only after a batch has been collected. In this case, the riser pipe, pod and discharge pipe are unnecessary. The riser pipe is replaced by a cable, which is used to raise the collector to the surface, where the nodules are emptied into the transport vessel, and to lower the collector back to the bottom to continue the collecting operation. Preferably, however, the collector is of the continuous type, i.e. nodules are continuously removed from the collector during the collecting operations.

The batch type collector is shown in detail in FIGS. 7, 8 and 9, and broadly comprises a framework comprising a pair of parallel triangular end sections **53** joined by structural reinforcing bar members **54**. Each end section **53** comprises a pair of parallel triangular plates **56** joined together by separator plates **58**. Disposed within the plates **58** are bearings **60** and a plurality of gears **62** and idler rolls **64**.

Housed in said bearings **60** is an axle **68** about which a basket **70** is rotatably mounted. The basket **70** has an axis which is concentric with the axle **68** and a center of gravity which is below the axle **68**. The basket **70** is constructed in a grill-like manner so that mud passes therethrough readily while nodules are trapped therein.

Affixed to the axle **68** is a collector wheel comprising a plurality of circumferentially spaced blades **72** rigidly attached to circular supporting end pieces **74**. The inner edges of the blades **72** are spaced from the axle **68** by a distance slightly exceeding the diameter of the basket **70**. The diameter of the circular end pieces **74** is large enough so that the blades **72** penetrate the ocean bottom during rotation of the blades.

Also concentric with the axle **68**, and having a radius slightly larger than the outer radius of the plurality of blades **72**, is a grillwork **76** extending from a point substantially directly under the axle **68** to a point at least slightly higher than the axle and rearwardly thereof. The grillwork **76** is provided with rake-like fingers **78** which penetrate the surface of the ocean floor during traversal thereof by the collector.

As the collector **18** is caused to traverse the bottom, the blades **72** partially penetrate the soil, causing the collector wheel, and hence the axle **68**, to rotate. Rigidly affixed to the axle **68** is a gear **80**, which, in combination with the gears **62**, drives a tread **82** in such a manner that the peripheral speed of the blades **72** is substantially equal to the peripheral speed of the treads **82**, and hence of the advance speed of the collector along the ocean floor. As a result of this relationship, the motion of those parts of the treads **82** in contact with the ocean floor relative to the ocean floor is practically zero. As a result, disturbance of the bottom soil is minimized and the strength of the soil is preserved.

Fairing pieces **84** surround the basket area to minimize fluid drag on the collector, thereby reducing the required hoisting power and also permitting a higher falling velocity. Rotatably secured to the axle **68** is a yoke **86** to which a tow line (not shown) is attached (instead of the riser pipe **16**).

The collector **18** is symmetrical about the axle **68**, and the center of gravity of the collector is between said axle **68** and the apex of the triangle having the fairing piece **84** as its base. Thus, said apex will be below the axle **18** when the collector is raised or lowered. When the collector is lowered, the apex will touch the ocean bottom first, and the collector will then fall on one working face or the other, depending upon the direction in which the collector is being towed.

While the above-described batch type collector may be used to harvest nodules, preferably a continuous collector, shown in detail in FIGS. **10–12**, is employed. The continuous collector comprises a framework comprising side plates **88** to which the pipe yoke **90** is rotatably connected. The yoke **90** is connected to the riser pipe **16**, and is provided with a dump valve **92** which opens automatically when there is no differential pressure and there is weight from a column of nodules and which closes automatically when said nodules are cleared from the pipe and differential pressure is reestablished.

The side plates **88** are provided with bearings **94** in which an axle **96** is adapted to rotate. Rigidly affixed to the axle **96** are internal gears **98** of the collector wheel **112** which are adapted to drive supporting treads **100** along the ocean floor. Also rotatably connected to the side plates **88** are idler wheels **102** for the tread **100**. Other wheels and/or plates (not shown) may also be provided to minimize upward deflection of the treads **100**.

Disposed within the side plates **88** above the axle **96** and about the pipe yoke **90** are bearings **104** which rotatably support a basket **106** for receiving nodules. Housed in the basket **106** are a pair of inclined gratings **108** which slope downwardly from the center of the basket toward its ends. There are outlets **110** provided at the lower end of each of the gratings **108**. Said outlets are disposed directly below the inlets to the pipe yoke **90** to insure adequate suction by preventing any accumulation of nodules in these areas.

A collector wheel **112** and grillwork **114**, substantially identical to those of the above-described batch type collector, are also provided. The collector wheel comprises blades **117** disposed in circular end pieces **119**. The collector wheel **112** is provided with internal gears **98** which drive the idler wheels **102** through pinions **113** and shafts **115** so that rotation of the collector wheel **112** causes the tread **100** to have a peripheral speed substantially equal to the peripheral speed of the collector wheel **112**.

The subject apparatus operates substantially as follows. The towing ship **10** is propelled to the mining site with the collector **18** docked between the twin hulls **26**. As shown in FIG. **1**, sections **32** of the riser pipe are stacked on the deck of the ship **10**, and the pod **14** is connected thereto by a towline. Upon reaching the mining site, the crane **36** is used to progressively connect sections of riser pipe **16** to the collector **18** until the collector is about **1500** feet above the ocean floor.

The pod **14** is then pulled between the hulls **26** and the riser pipe **16** is connected to the swivel joint **51**. The pod is deballasted sufficiently to support the weight of the riser pipe **16** and the collector **18**. The discharge pipe **20** and tow-power cable **12** are then connected to the pod **14** and the pod is ballasted until the collector **18** rests on the bottom with the proper force. The pump **50** is next energized, and the tow ship **10** traverses a prescribed course over the area to be mined.

If heavy seas are expected, the tow-power cable **12** is detached from its fittings and attached to a buoy (not shown). Also, that section of the discharge pipe **20** extending from the buoy **24** to the transport ship **22** is detached from the buoy **24**. As a result, the tow ship **10** and the transport ship **22** are free to ride out the storm independently, while the pod **14** and riser pipe **16** are far enough below the surface of the water to be unaffected by the heavy seas.

The continuous collector **18** operates substantially as follows. The riser pipe **12** pulls the collector along while the blades **117** of the collector wheel penetrate

the soil, causing the wheel to rotate and push nodules onto the grillwork **114**. Further rotation of the wheel causes the nodules to be trapped within the space bounded by the blades **117**, the grillwork **114** and the basket **106**. Still further rotation of the wheel carries said nodules up to a point where they slide off the blades **117** and fall into the basket **106**. Said nodules impinge on the inclined gratings **108** and slide downwardly toward openings **110**. If there is suction in the riser pipe **16**, said nodules will be sucked into the inlets to the pipe yoke **90**.

The operation of the batch type collector is substantially similar to that of the continuous type collector except that nodules falling into the basket remain therein until the collector is raised to the surface and emptied.

To recover the continuous type collector **18**, the installation procedure is reversed. The towing vessel is stopped, the riser pipe **16** is cleared of nodules, and the pump **50** is stopped. The pod **14** is then deballasted sufficiently to cause it to float to the surface. It is then towed between the hulls **26** of the transport ship **10** and further deballasted until it presses against the bottom of the platform **28**. The riser pipe **16** is then disconnected and hung from the crane **36**. The pod **14** is next ballasted and floated away from the vicinity of the riser pipe **16**. Sections of the riser pipe are disconnected and stacked, one at a time, on the platform **28** until the collector **18** reaches the surface.

I claim:

1. In apparatus for mining solid material from the floor of a body of water, a device for collecting said solid material comprising:

a. a framework;

b. at least two treads adapted to support said framework on said bottom;

c. a basket rotatably attached to said framework;

d. means, rotatably attached to said framework and concentric with the axis of rotation of said basket, comprising a plurality of circumferentially spaced blades, the inner edges of said blades being spaced from said axis by a distance slightly exceeding the maximum width of said basket, the outer edges of said blades being adapted to penetrate said floor of said body of water during rotation of said blades about said axis;

e. means interconnecting means (d) with said treads whereby the peripheral speed of said blades and the peripheral speed of said treads are substantially equal; and

f. means, concentric with said axis and having a radius slightly larger than the outer radius of said plurality of blades, comprising a grillwork extending from a point substantially directly under said axis to a point at least slightly higher than said axis and rearwadly thereof relative to the direction of framework advance.

2. A device as recited in claim 1, in which said basket comprises:

1. a pair of oppositely disposed outlets; and

2. a pair of inclined planes disposed so that solid material falling in said basket is directed toward said outlets.

3. A device as recited in claim 1, in which:

1. said framework and said grillwork are symmetrical about the axis of rotation of said basket and with respect to the apex of an isosoles triangle having said treads as its sides; and

2. the center of gravity of said device is between said axis and said apex.

* * * * *