# United States Patent

[11] **3,588,174**


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[54] **COLLECTOR ASSEMBLY FOR DEEP SEA MINING**
**14 Claims, 14 Drawing Figs.**


[52] **U.S. Cl.** ..... **299/8,** 37/57, 37/63
[51] **Int. Cl.** ..... **E02f 7/00**
[50] **Field of Search** ..... 299/8, 9; 37/57, 58, 62, 63



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,305,950 | 2/1967 | Hirshman et al. | 37/58 |
| 3,429,062 | 2/1969 | Nelson | 37/Nodule Digest |

FOREIGN PATENTS

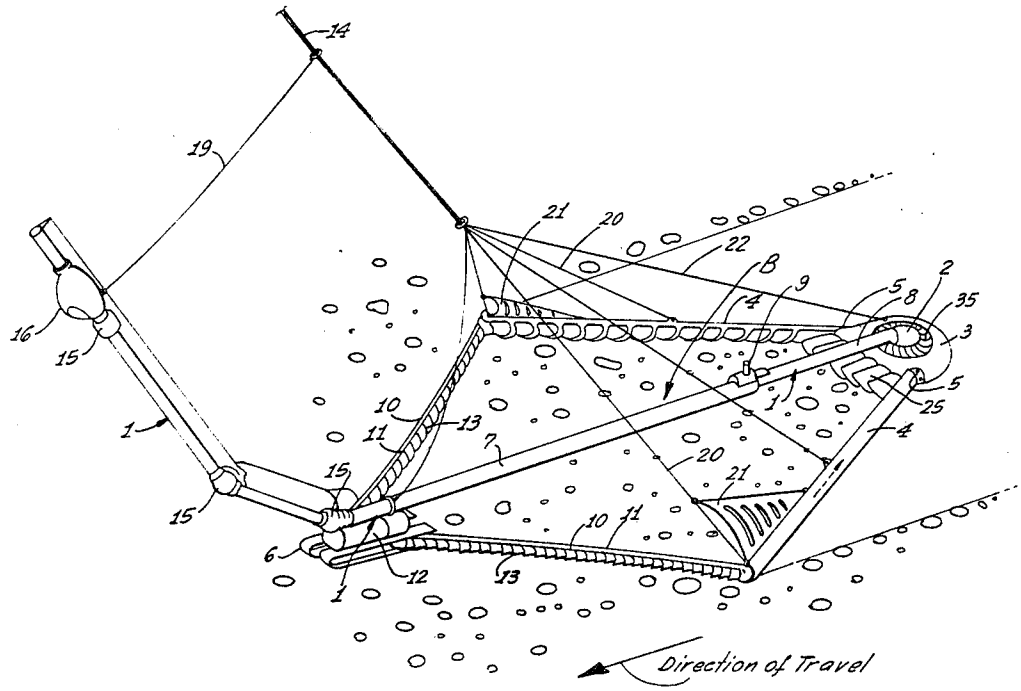
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| 794,724 | 9/1968 | Canada | 37/Nodule Digest |



*Primary Examiner*—Ernest R. Purser
*Attorney*—Thomas D. Linton, Jr.



**ABSTRACT:** A collector assembly is provided which may be towed on the ocean floor for mining loose aggregate, the aggregates being lifted to the surface by means of a water stream which flows upwardly from the collector. The collector to be described is foldable, and it is fully deployed only when immersed and ready for operation. Hydraulic means is provided for gathering and conveying the nodules toward the intake to the aforesaid water stream. Ground traction of the collector is provided by means, for example, of a combined tow from a riser and from a follower pendant which is rigged on the collector through sidelines similar to those used in the fishing gear art.

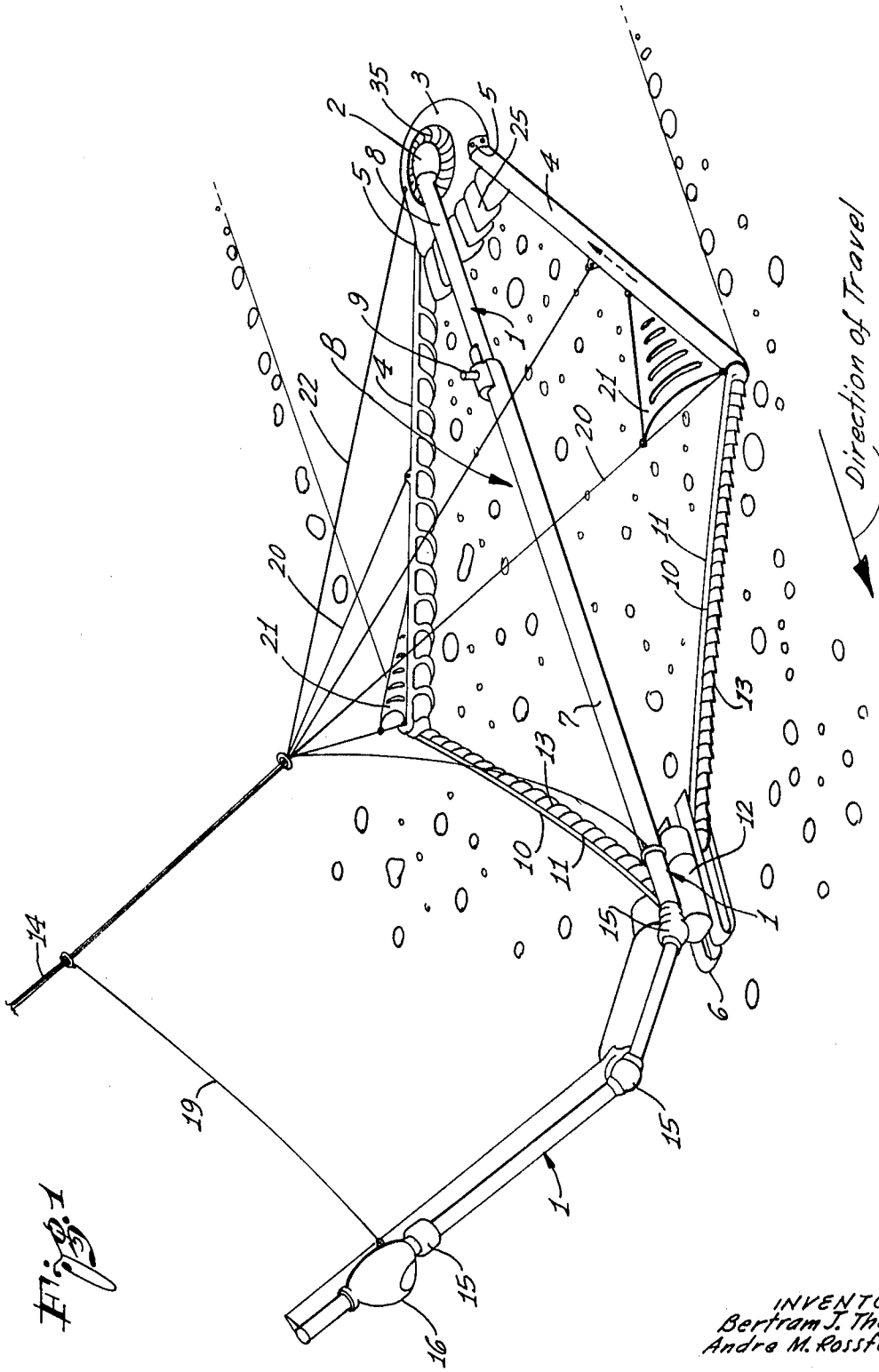



Fig. 1

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Fig. 2

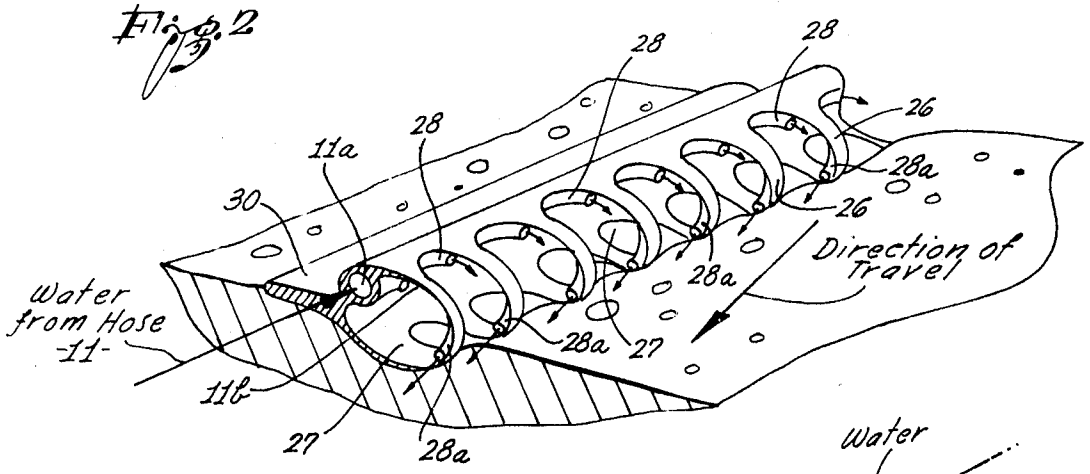



Fig. 3

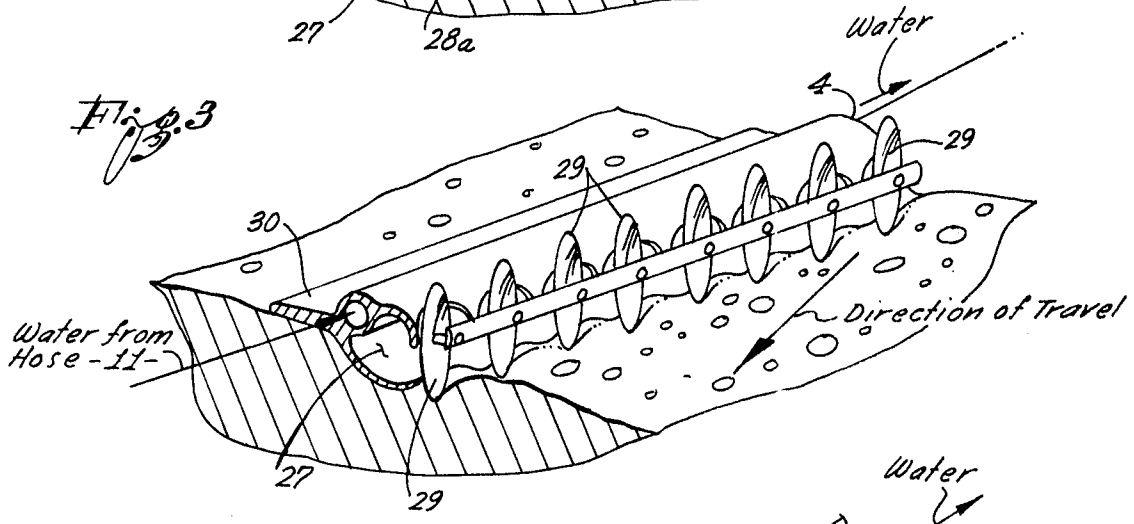
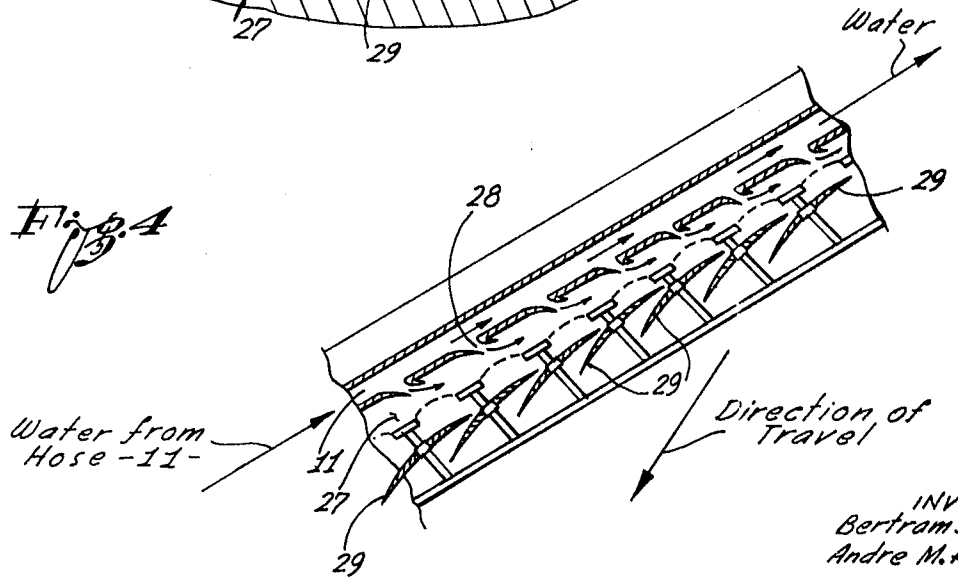



Fig. 4




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Fig. 5

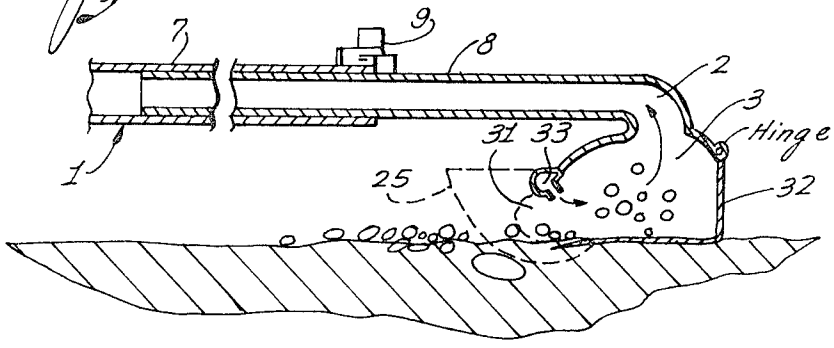



Fig. 7

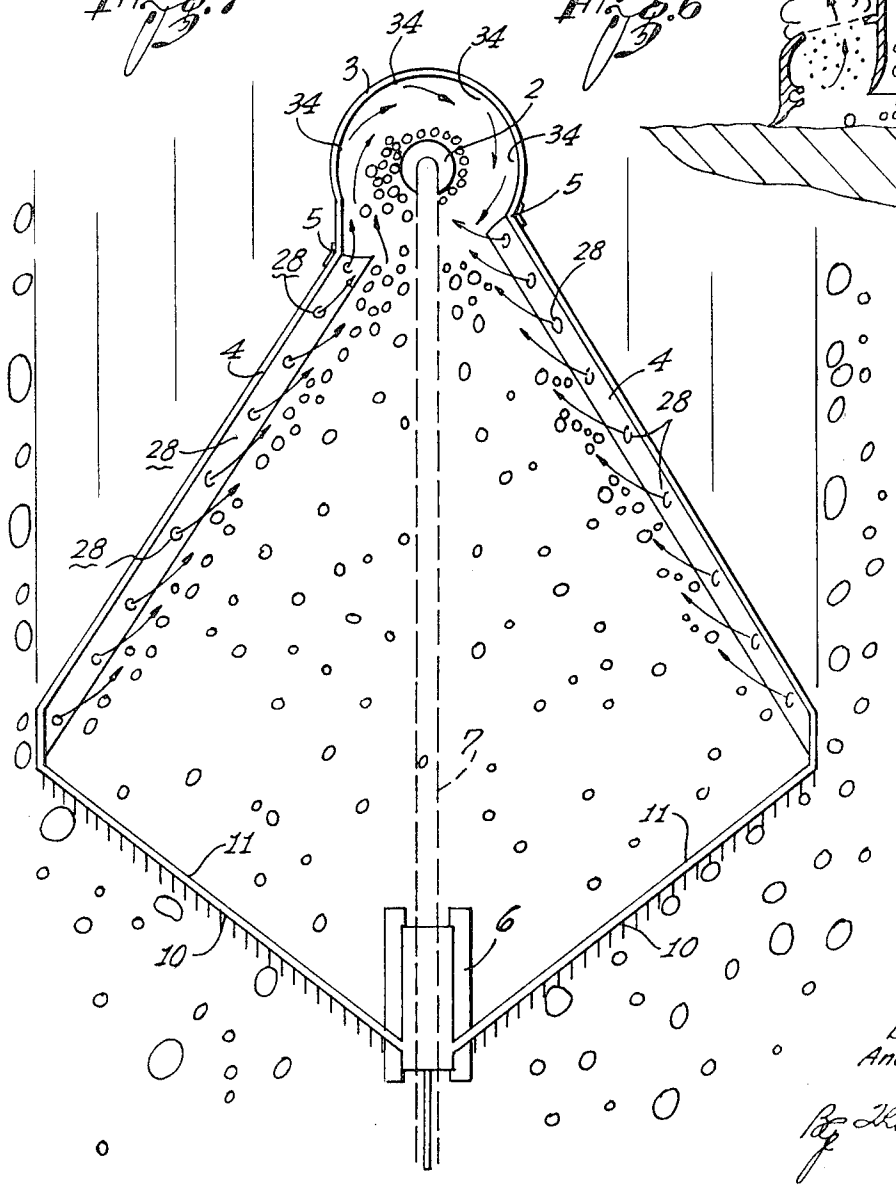
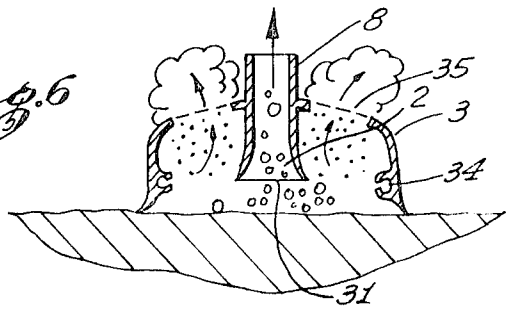



Fig. 6




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Fig. 8

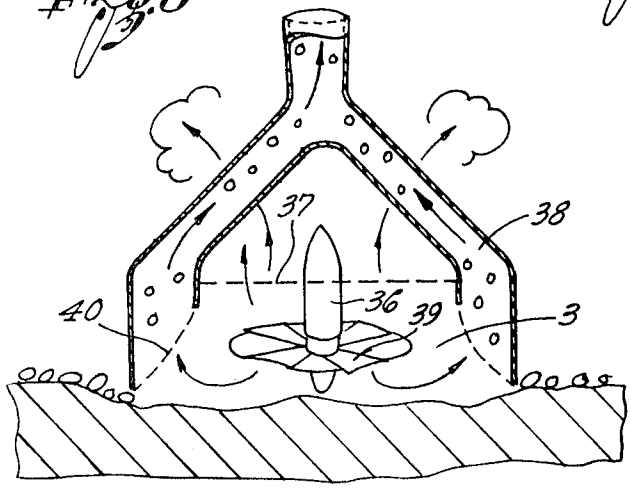



Fig. 10

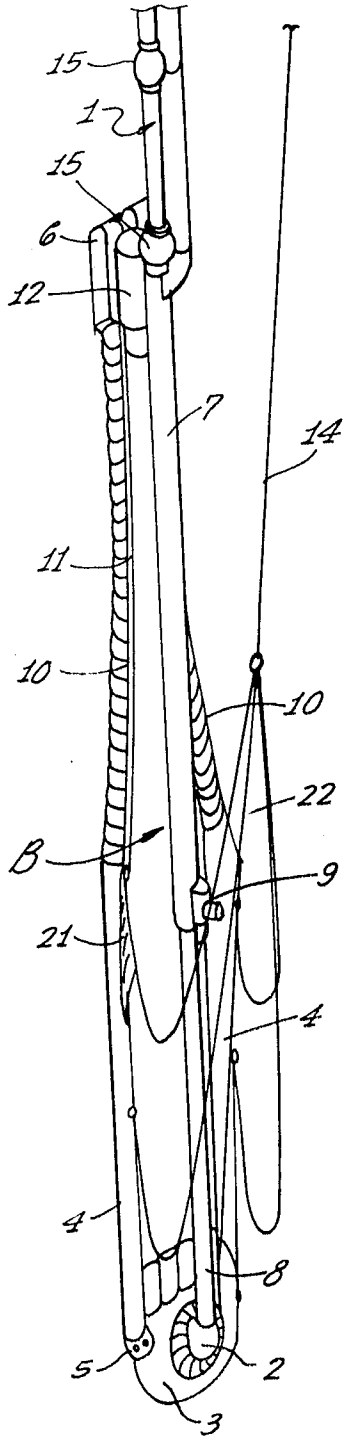
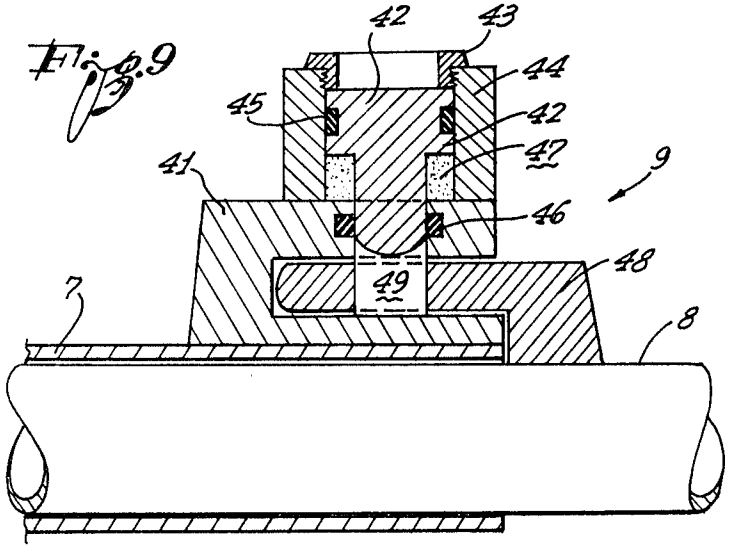



Fig. 9




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Fig. 11

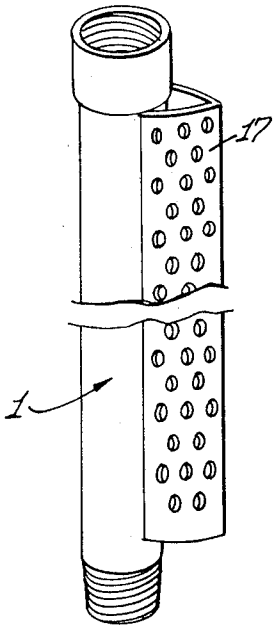



Fig. 13

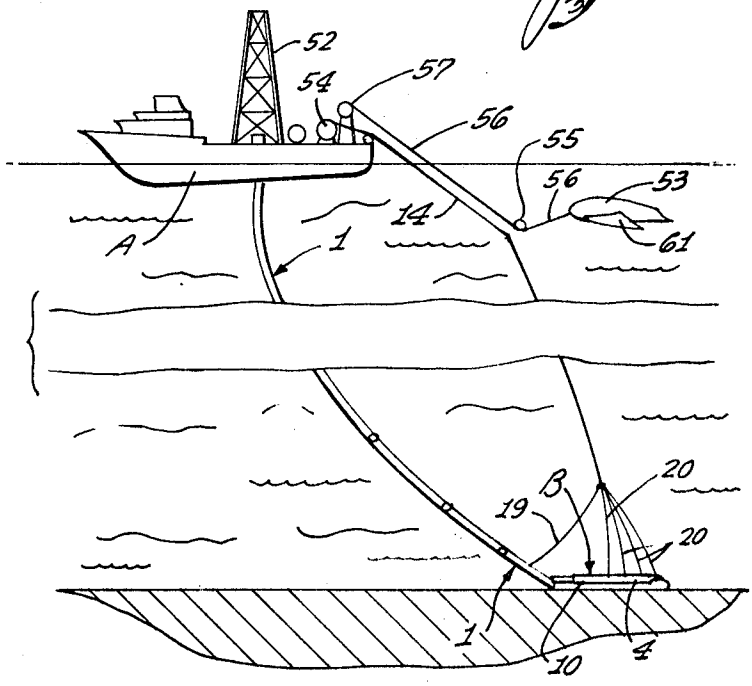



Fig. 12

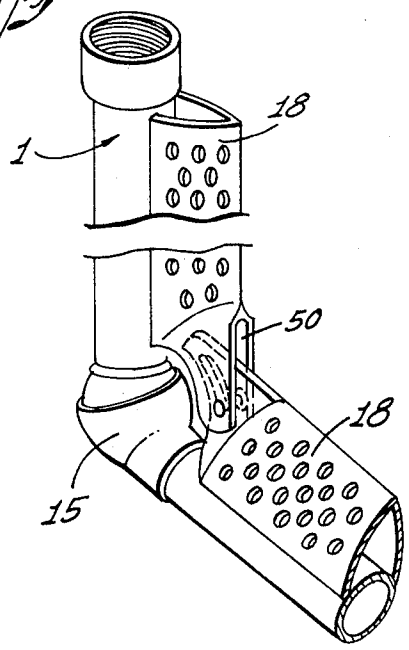
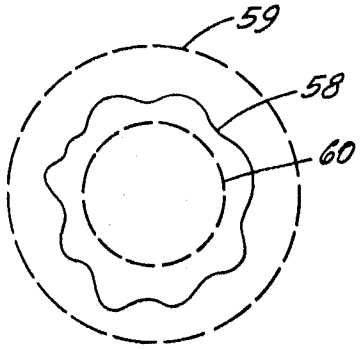



Fig. 14




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# COLLECTOR ASSEMBLY FOR DEEP SEA MINING

## BACKGROUND OF THE INVENTION

Ferromanganese nodules are known to occur in large quantities on the bottom of the ocean, and these nodules are usually disseminated over vast areas of the deep sea floor. Lifting the ferromanganese nodules to the surface by means of a stream of water in a closed conduit appears to be the best method of recovery. The stream of water may be produced, for example, by means of a suction pump at the surface; by a series of immersed pumps situated at spaced positions along the conduit, or riser, which extends from the underwater collector to the surface; or by means of compressed air injection a different points into the riser. To be commercially practical, however, such a recovery system must include a collecting device capable of gathering the ferromanganese nodules towards the suction intake of the riser at a high sweeping rate so that sufficient amounts of nodules may be recovered over any predetermined period to make the operation commercially feasible. The sweeping rate depends upon the ground speed of the collector and the swath defined thereby.

The usual prior art collector of the general type under consideration is a rigid assembly, and the size and resulting swath defined by the usual prior art collector is limited by the handling capabilities of the surface control facility. Also, the prior art collectors for the most part include no provision for improving the ground speed or for making the towing operation more efficient by lowering the drag coefficient of the riser.

The collector assembly to be described, on the other hand, is foldable so as to be easily handled by the support facility, and it is deployed only when immersed. The collector assembly of the invention may also include a streamlined riser conduit, as will be described, so that the collector may be moved freely at a relatively high ground speed. In addition, hydraulic means is provided in the collector assembly of the invention for gathering and conveying the nodules toward the suction bin at the intake to the riser. The hydraulic means also provides an agitating action on the nodules, which serves to sort the nodules, and which also serves as a means for the dispersion of fine sediment from the nodules so that such sediment is not drawn up through the riser.

As mentioned above, ground traction for the collector assembly to be described is provided by a combined towing action of the riser and a follower pendant. The follower pendant is rigged to the collector through sidelines which, as also mentioned above, have been used in the fishing gear art. The pendant is supported by a controllable buoyancy package which is towed by the surface craft at a lesser depth than the collector assembly. The control of the buoyancy of the aforesaid package allows for control of the lifting force exerted by the pendant on the collector, and, consequently, of the net weight of the collector on the sea floor.

Extension of the gathering arms of the collector assembly to a deployed position, when the assembly to be described is submerged, is assured by the operation of the surface craft; and an automatic pressure actuated latching device may be incorporated into the assembly in order to maintain the gathering arms locked in their deployed position whenever the collector is below a certain depth.

Moreover, if so desired, any appropriate remote controlled means may be used for opening and closing the gathering arms when the collector assembly is in operation on the sea floor, so as to control the rate at which the nodules are fed to the intake of the riser. Appropriate sensing means may be incorporated into the overall assembly, so that the rate at which the nodules are fed through the riser to the surface is indicated, and the remote controlled means may be operated accordingly so as to maintain a predetermined flow rate. Such sensing means, for example, may be a television camera, electrical resistivity sensors, magnetometers, and the like.

As will also be described, a front sled may be incorporated in the collector assembly in order to support the lower end of the riser, and the sled may be used also to support a pump which sets up hydraulic flow in the assembly to draw the nodules into the gathering arms. Further ground traction means may be incorporated such as, for example, a powered crawler or buggy.



## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective representation of one embodiment of the collector assembly of the present invention, and which incorporates the principles and features of the invention;

FIG. 2 is a detailed perspective representation of the gathering arms of the collector assembly of FIG. 1, and illustrating the direction of water flow which conveys the nodules towards the suction bin at the intake of the riser conduit;

FIG. 3 is a perspective representation of a modified structural design for the aforesaid gathering arms;

FIG. 4 is a section view of the representation of FIG. 3, taken along the line 4–4 of FIG. 3;

FIG. 5 is a side sectional view of the aforesaid suction bin;

FIG. 6 is a front elevation of the suction bin in a particular embodiment in which agitation and sorting of the aggregates is achieved by means of a centripetal vortex;

FIG. 7 is a top plan view of the collector assembly of FIG. 1 with certain of the elements removed, so that the manner in which the nodules are conveyed in the gathering arms and into the suction bin may be shown;

FIG. 8 is a front elevation of a modified type of suction bin, whereby agitation and sorting of the nodules is carried out by means of a centrifugal vortex;

FIG. 9 is a side sectional view of an automatic pressure-actuated latch which locks the gathering arms of the collector in their open deployed position when the collector is submerged;

FIG. 10 is a perspective representation of the collector assembly of FIG. 1, and showing the assembly near the surface of the ocean and in a folded configuration, for example, prior to being submerged into the operating depth of the ocean, or after it has been retrieved from its operating depth;

FIG. 11 is a perspective representation of a portion of the riser, and showing streamlined elements associated with the riser;

FIG. 12 is a further perspective representation of a portion of the riser, and shows certain articulation and reinforcement means which are provided in the lower part of the riser;

FIG. 13 is a general representation of the deployment of the collector assembly of the invention, illustrating particularly the combination of the cable pendant and the controllable buoyance follower; and

FIG. 14 is a diagrammatic representation of the principle of the buoyant ship follower having an upper limit of expansion and lower limit of contract.

## DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

The system shown in the drawings, and with particular reference to FIGS. 1 and 10, includes a conduit 1 which serves as a riser from the collector assembly B on the ocean bottom. A stream of water is drawn up through the riser, and this stream serves to carry the nodules from the sea floor toward the surface support craft A (FIG. 13). The riser 1 extends through the hull of the support craft A into appropriate machinery within the craft. A suction intake structure 2 is provided at the lower end of the riser 1 and at the rear of the collector assembly, the suction intake 2 being surrounded by a suction bin 3 in which the nodules are gathered. The bin 3 supports two extended arms 4 of the collector assembly, these arms being fastened to the bin by means of hinges 5.

The riser 1 is supported on a sled 6 at the forward end of the collector assembly, and the riser serves to link the sled to the suction bin 3. The link is actually provided by two telescoping tubular members 7 and 8 of the riser assembly, and which may be locked to one another with any degree of mutual extension by means of an appropriate latch 9. Two front wings or arms 10 extend out from the sled 6 towards the ends of the arms 4.

The wings 10 are pivotally movable about the sled 6. Therefore, the collector assembly includes the two side arms 4, and the two front wings 10, and the telescoping tubular members 7 an 8 of the riser, so as to have a diamondlike configuration which can be opened or closed by sliding the tubular member 8 in and out of the tubular member 7.

The purpose of the arms 4 is to collect, gather and convey the intercepted nodules towards the suction bins, and the purpose of the wings 10 is to provide the necessary link between the arms and the sled 6 in order to control the opening of the arms 4, and also to transmit the towing force of the surface craft A, which is exerted through the riser 1, and through the wings 10 to the ends of the arms 4.

In addition, the wings 10 in the embodiment illustrated in FIGS. 1 and 10, for example, serve as a support for a flexible reinforced hose 11. The hose 11 is coupled to the outlet of a powered pump 12 supported on the sled 6, and pressurized streams of water are forced through the hoses 11 by the pump 12 to provide the water flow used by the arms 4 for conveying the nodules toward the entrance to the suction bin 3, as will be explained in more detail subsequently herein.

The wings 10 also incorporate a series of harrowing blades 13, and these blades serve to dislodge the nodules from the sediment on the ocean floor as the collector is drawn across the floor in the direction shown by the arrow in FIG. 1, and also to discard oversized nodules, boulders or rocks, which merely pass the outer sides of the wings.

As mentioned above, the collector assembly B of FIGS. 1, 10 and 13 is towed and supported by the riser 1, and also by pendant 14. The riser 1 includes several ball joints 15 in its lower end adjacent the front of the collector assembly B, as shown in FIG. 1, so as to provide flexibility in the assembly, and so that the collector B may be manipulated easily during launching and retrieval, and also so that it may assume the proper orientation on the floor of the ocean when it is in operation. An emergency discharge valve 16 (FIG. 1) may also be provided which allows for a quick discharge of the contents of the riser in the event of power failure or clogging. The riser may be fitted with streamlining attachments and are reinforcements 17 and 18 which are shown, for example, in FIGS. 11 and 12, and which will be described in more detail subsequently.

A sideline 19 extends from the pendant 14 to the discharge valve 16, and a further plurality of sidelines 20 extend from the pendant to various attaching points on the collector assembly B, as best shown in FIG. 1. The pendant 14 includes an armored power cable for providing power to the pump 12, and the closing or opening of the discharge valve 16 may be controlled through the sideline 19. The additional sidelines 20 are also fastened to the ends of the arms 4, as shown, and are there provided, for example, with otterboards 21 which take the form of flexible slotted panels serving as sails to maintain the arms 4 in their deployed position as the collector assembly B is drawn along the ocean bottom. A mainline 22 connects the pendant 14 to the suction bin 3, and serves to support the suction bin end of the collector assembly B during launching and retrieval, as shown in FIG. 10, and which likewise will subsequently be described in more detail.

The suction bin 3 receives the nodules through moon-shaped blades 25 at the forward end of the bin, an these blades prevent oversized elements from entering into the suction entrance 2 of the riser 1.

One possible construction for the gathering arms 4 is shown in FIG. 2, in which the illustrated arm includes a series of curved blades 26 which serve to dislodge the nodules collected as the arm moves in the direction of the arrow, so that the nodules are collected in a corridor 27 within the arm. The blades 26 have a conical profile and could, in fact, be substituted by a series of conical elements. The flow of water from the pump 12 of FIG. 1 circulates from the hose 11 into a duct 11*a* extending through the arm 4, the duct having a series of nozzles 28 therein which direct water jets toward the rear of the corridor 27. The function of the water jets from the nozzles 28 is to clean the mud from the blades 26, and also to agitate the sediment and disperse the fine particles. The water jets extending through the nozzles 28 also serve to direct the nodules towards the suction bin 3 through the corridor 27.

In order to stabilize the arm 4 on the sea floor, and to set the depth of penetration of the blades 26, the back of the arm 4 is extended into a striplike configuration 30. Further ducts, such as the duct 11*b*, may extend from the duct 11*a* around the blades 26, and the ducts 11*b* may terminate in further nozzles 28*a*. The nozzles 28*a* direct a series of jets of water downwardly, as shown by the arrows, to assist in dislodging the nodules.

In the modification of FIG. 3, a series of harrowing discs 29 are substituted for the blades 26, and these discs may be similar to those presently used on farm machinery for tilling purposes. The blades 26 or discs 29 may be composed of stainless steel. However, more resilient materials may be used for the remaining structure of the arm 4 so as to provide some flexibility in the vertical plane and sufficient rigidity in the horizontal plane, so as to take into account the unevenness of the sea floor and the need for transverse structural strength as the arms shear through the sediment on the floor.

As mentioned above, the suction bin 3, as well as the telescoping tubular sections 7 and 8 of the riser 1 are shown in section in FIG. 5. The nodules gathered at the entrance of the suction bin are sucked in by the water flow toward the intake 2 of the riser 1. The blades 25 are regularly spaced across the entrance of the suction bin 3, and these serve to discard the oversized nodules, such as the nodule 70, by pushing them under the bin. A hinged shutter 32, which is maintained closed during operation by the water suction, acts as a discharge door when the water circulation is stopped in the riser and when the collector assembly is raised up from the bottom in a vertical position, such as shown in FIG. 10. A nozzle 33 may also be located at the entrance 31 of the bin 3, and these nozzles may be coupled to the hose 11, so as to provide water jets at the entrance 31 to disperse the mud and avoid clogging of the entrance.

The suction bin 3 is shown in greater detail in FIGS. 6 and 7, and the latter representations also show the manner in which the water flow from the pump 12 through the openings 28 serve to direct the nodules towards the bin 3. Also, a further series of nozzles 34 which are coupled to the conduits in the arms 4 to receive water pressure produce jets within the bin 3 so as to create a centripetal vortex.

The latter nozzles, as shown in FIG. 7, are distributed around the inner wall of the bin 3 with a particular orientation, so that the pressurized water jets emitted from the nozzles 34 extend in the directions of the arrows to create the aforesaid vortex. As a consequence, the sediment and other undersized particles will tend to be dispersed upwardly and will be evacuated through a circular screen 35 at the top of the bin, and as shown in FIGS. 1 and 6. The larger particles, however, are concentrated in the central part of the bin and are drawn into the intake 2 of the section 8 associated with the riser 1.

In the modification of FIG. 8, a centrifugal vortex is created for the same purpose by a central turbopropellor 36 which may be electrically powered by means of connections through the pendant 14. In the latter embodiment undersized material is discarded through a fine mesh screen 37 (FIG. 8), while the larger aggregates are drive outwardly by the blades 39 of the turbopropellor 36 by centrifugal action and are drawn through the larger mesh screens 40 into the intake suction ducts 38 of the riser 1. In addition, the propeller blades 39 serve to crush the aggregates so that the oversized material may be recycled within the bin 3 until it is crushed to a size sufficient to be passe through the screen 40.

The latch 9 for the telescoping tubular members 7 and 8 of FIG. 1 may be a pressure-sensitive mechanism, such as represented by the sectional view of FIG. 9. The latch, for example, includes a lock 41 which is supported on the tubular casing 7, and a piston 42 which is held by a retaining ring 43 in a cylindrical chamber 44 mounted on the lock 41. The piston

42 is sealed in the chamber 44 by an appropriate O-ring seal 45, and it includes a lower portion of reduced diameter which extends into an aperture in the lock 41, and is sealed therein by means of an O-ring 46.

Air at atmospheric pressure is trapped within the space 47, between the upper part of the piston 42 and the bottom of the chamber 44. At a particular depth, hydrostatic pressure will push the piston 42 down against the atmospheric pressure of the air in the space 47, and through an aligned hole 49 in the lock 48 on the tubular member 8.

Therefore, so long as the assembly is above a certain depth within the water, the telescopic tubular members 7 and 8 are free to move back and forth with respect to one another. However, when the collector assembly B is open to the position shown in FIG. 1, and when a predetermined depth has been exceeded, the piston 42 of the latch 9 moves down into the hole 49 so as to latch the locks 41 and 48 together, and thereby hold the tubular members 7 and 8 in their retracted position illustrated in FIG. 1, and with the collector assembly opened to its operational state which is also illustrated in FIG. 1.

Therefore, in order to launch the collector assembly of the invention, it is originally lowered in its folded condition, as shown in FIG. 10. The pendant 14 is then pulled by a winch 54 on the surface craft A to open the assembly and deploy it to the position of FIG. 1, and the assembly is now lowered by means of the riser 1 and pendant 14 until it reaches a depth where the pressure actuated latch 9 operates so as to lock the arms 4 and the wings 10 in their open position. During the retrieval operation, the latch 9 will automatically be unlocked when the assembly reaches a certain depth, so that it may be folded into the condition shown in FIG. 10 and pulled up onto the surface craft A.

Although air at atmospheric pressure has been described as trapped within the chamber 47 in FIG. 9, it is evident that other compressible fluids, such as silicone compounds may be substituted. Moreover, a spring may also be incorporated into the space 47 in order to increase the reliability of operation of the mechanism. If desired, other more elaborate mechanisms may be used instead of the latch of FIG. 9 to latch the tubular members 7 and 8. For example, various powered arrangements, such as gears or hydraulic actuators may be used with suitable remote controls, to move the tubular members 7 and 8 in and out of one another and to latch the members in their retracted state. Moreover, if so desired, a simple linear hydraulic actuator coupled to the intake 2 of the riser 1 may be used in order to extend the tubular members 7 and 8 to their operating positions of FIG. 1 and thereby deploy the collector assembly B when the pumping operation starts in the riser 1.

As mentioned above, the riser pipe 1, as shown in FIG. 11, may include streamlining elements 17, and these may consist, for example, of a sheet of plain, expanded or perforated metal extending from one end to the other of each length of the riser. The elements 17 have a triangular configuration, with the apex of the triangle displaced out from the riser element for streamlining purposes. The reinforcements provided at the lower part of the riser near the collector assembly B and around the ball joints 15 are designated 18 in FIG. 12. These latter reinforcements may be similar to the streamlining elements 17, and they provide a streamlining and reinforcing structure which interlock around the ball joints 15 through an arresting hinge 50.

A schematic showing of the system of the invention deployed from the surface craft A is shown in FIG. 13. The pendant 14 is supported on an immersed ship follower buoy 53 which is towed back of the ship, and the pendant itself is operated by a winch 54. A pulley 55 is attached to the pendant to be submerged a particular depth under the water during the operation of the assembly B. A cable 56 from a further winch 57 passes through the pulley to the buoy 53. A draw works for the riser 1 is mounted on the surface craft A, and is designated 52.

The buoy 53 serves to keep the pendant 14 away from the riser 1, and it also provides a controllable lifting force on the collector assembly B so as to adjust its effective weight on the sea floor for various ocean depths. Such depth control is important since the topography of areas favorable for deep sea mining consists essentially of rolling hills with gentle slopes and small elevation changes. Therefore, the ship follower buoy 53 is provided with a air chamber which may expand and contract within an upper and lower limit, as shown in principle by the diagram of FIG. 14. This chamber, may be a rigid cylindrical housing closed on one side by a free piston which can move within two extreme positions.

Alternately, in the embodiment represented by FIG. 14, the ship follower buoy comprises a resilient pouch 58 which is filled with compressed air and enclosed in a shell 59 open to sea water. A second shell 60 is provided within the pouch 58 in order to limit its lower volume of contraction. It is thus apparent that by acting through the winch 57 and cable 56, the depth of immersion of the ship follower 53 may be easily controlled. Consequently, the buoyancy and the lifting force exerted by the ship follower buoy 53 on the collector assembly B, through the pulley 55 and pendant 14, can be adjusted. Moreover, this adjustment will not be affected by sea surface conditions. Depressor wings 61 on the buoy 53 may be provided in order that the higher towing speeds do not produce excessive lifting forces on the buoy.

The ship follower buoy 53 may also be used to insure a controllable lifting force on the collector assembly B if a compressed air hose were substituted for the cable 56 and connected to the pouch 58 of the ship follower. With a compressed air source and necessary control valves on the vessel A, the pouch 58 in the ship follower buoy, or a series of pouches 58, may be easily inflated or deflated in order to control the buoyancy of the buoy and the resulting force on the pendant 14.

In the operation of the system and apparatus of the invention, the collector assembly B is lowered in a folded condition, such as shown in FIG. 10, with the pendant 14 fastened to the assembly but slackened from the stern. Pipe elements of the riser 1 are assembled while the collector assembly is lowered. Before reaching the depth of actuation of the lock 9, which may, for example, be around 200 feet, the pendant 14 is tightened and the collector assembly B is consequently deployed open by the retraction of the telescopic tubular members 7 and 8. The telescopic tubular members are subsequently latched by the latch and with the collector assembly B in its deployed condition, and the collector assembly is then lowered to the sea floor with the surface craft A proceeding at a very slow forward speed.

The pendant 14 is then released through operation of its winch 57 in order to permit the sidelines to be maintained with the proper degree of tautness. The ship speed is then increased to the operating speed and the ship follower buoy 53 is placed in position on the pendant 14, while the pumping operation starts in the riser 1. The submerged pump 12 on the collector is also started, so as to cause the aggregates to be conveyed into the gathering arms 4 as soon as the collector assembly B reaches the sea floor. With the surface craft underway at operating speed, the soil at the ocean bottom is presheared, and the nodules partly dislodged by the rake wings 10. The wings discard parts of the oversized material around the sides of the collector assembly. Then, the gathering arms 4 collect the nodules and disperse the undersized elements, and pass over the oversized material, so that the nodules are conveyed towards the rear suction bin 3. Oversized material shifted towards the suction bin 3, or still remaining in its path, are sheared or overpassed by the frontal blades 25 of the suction bin.

Topography changes in the path of the collector assembly B, as monitored, for example, by sounding means on the surface craft A, are taken care of by operating the ship follower winch 57 and, if necessary, the pendant winch 54. In the case of drastic change in the ocean bottom, such as outcrops, the

pendant and riser effectively lift the collector assembly B above the sea floor and cause it to move over the obstacle

When the assembly is retrieve aboard the surface support craft A, the lock 9 disengages itself when a particular depth is reached, and the collector moves itself into the position shown in FIG. 10 so that it may easily be raised by the rig in the surface craft.

During the operation, if clogging occurs within the riser 1, the discharge valve 16 is actuated and the collector assembly B is lifted over the discharged material through operation of the ship follower buoy 53. If clogging occurs within the collector assembly B and the suction bin 3, a higher speed of the ship and the slack on the pendant 14, as controlled by operation of the winches 54 and 57, will bring the collector assembly into the hanging position of permitting discharge of the material through the shutter 32.

The invention provides, therefore, an improved collector assembly for gathering loose aggregates on the ocean bottom, and for feeding the aggregates to a suction intake at the lower end of a riser pipe extending to the surface, the assembly having the capability of assuming a folded configuration for ease of manipulation an operation, as described above.

We claim:

1. In a collector assembly for gathering loose aggregates from the ocean floor, and which includes a riser conduit extending to the surface in which a suction pressure is established for drawing water and aggregates through suction intake at the lower extremity of said conduit, the combination of:

a bin member coupled to the lower end of said conduit and surrounding the aforesaid suction intake, said bin member having an open portion at the forward side thereof defining a mouth therefor;

a pair of elongated gathering arms affixed to said bin member and extending forwardly therefrom in an angular relationship on opposite sides of said mouth;

and a plurality of nozzles positioned on said gathering arms and directed toward said bin member to provide pressurized water jets within the confines of said gathering arms and which serve to dislodge and agitate the aggregates, and to convey the aggregates towards said mouth of said bin member.

2. The combination defined in claim 1 and which includes a series of scraping blades mounted on each of said gathering arms and having an arcuate configuration to be drawn with a shearing action along the ocean floor as the collector assembly is moved in a forward direction.

3. The combination defined in claim 1 and which includes a series of rolling discs mounted on each of said gathering arms and providing a tilling acting in the ocean floor as the collector assembly is moved forwardly therealong.

4. The combination defined in claim 1 in which a portion of the riser conduit extends forwardly in essentially uniplanar relationship with said gathering arms and essentially bisecting the angle formed by said gathering arms; and which includes a support vehicle for said riser positioned at the forward end of the assembly and movable along the ocean floor as the assembly is so moved.

5. The combination defined in claim 4 and which includes a pair of elongated wing members extending from said support vehicle to the ends of corresponding ones of the aforesaid gathering arms; and which includes a pump mounted on said forward vehicle, and hose members extending from the pump along said wing members to the forward ends of said gathering arms to supply pressurized water from said pump to said arms to be emitted as the aforesaid water jets through said nozzles.

6. The combination defined in claim 5 in which said gathering arms are hinged to said bin member, and in which said portion of said riser conduit between said support vehicle and said bin member includes a pair of telescoping tubular components, so as to permit said gathering arms and wing members to be moved between a deployed and a folded condition.

7. The combination defined in claim 4 in which said support vehicle is in the form of a sled slidably movable along the ocean bottom with the collector assembly.

8. The combination defined in claim 1 in which said bin member has an annular configuration, and which includes a plurality of nozzles mounted on the inner wall of said bin member for providing pressurized water jets within said bin member serving to create a centripetal vortex within the bin member to direct the aforesaid aggregates towards said suction intake and to disperse sediment and finer particles.

9. The combination defined in claim 1 and which includes a powered turbopropellor unit within said bin member providing a centrifugal vortex in order to disperse sediment and finer particles, and to crush oversized particles of the aggregates, said suction intake being disposed about the inner periphery of said bin member, and said turbopropellor unit serving to project aggregates towards said periphery and into said suction intake.

10. The combination defined in claim 1 and which includes a series of moon-shaped upright blades positioned at the mouth of said bin member to shear or overpass oversize aggregates and obstacles.

11. The combination defined in claim 1 and which includes tapered members mounted on said riser conduit to decrease the drag coefficient of said conduit.

12. The combination defined in claim 1 and which includes a supporting pendant for the collector assembly extending to the surface, and a submerged buoyant vehicle coupled to said pendant for maintaining the pendant in a taut condition.

13. The combination defined in claim 12 in which said buoyant vehicle includes a perforated protective shell open to the external water, and a variable volume chamber located inside said protective shell.

14. The combination defined in claim 13 and which includes means for introducing a pressurized fluid into said chamber for controlling the amount of inflation thereof.