An economic method and apparatus for ecologically safely removing silt, muck, and sand from a water bottom and for collecting the silt, muck, and sand without destroying the benthos therein into porous containers where the then contained mud and silt can be ecologically positioned where desired to enhance subaquatic environments. The apparatus includes a silt and mud collecting and transfer device that has no moving parts and uses low kinetic energy movement of large masses at low terminal velocity, thereby not endangering the benthos or the porous containers in the transfer process.
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METHOD AND APPARATUS FOR TRANSFERRING MUD AND SILT

BACKGROUND OF THE INVENTION

1. Field of the Invention

An apparatus and method for ecologically, safely transferring muck and silt from water bottoms that includes the transfer of muck and silt, using a portable, submersible, robotic power head that can transfer plants and living creatures, large and small, that live on or in the water bottom, without damage thereto, and providing porous containers on the water bottom for receiving the silt or muck, which also allows for a continuing supply of nutrients and food to support sea plants, crustaceans, fish, crabs, and sea animals on the outside of the porous containers.

2. Description of the Prior Art

Rain and wind-driven organic and inorganic matter produced by animals and plants of all types flows down from mountains, farms, ranches, factories, streets, roads, driveways, roofs, airports, golf courses, septic tanks, horse and cattle ranches, and cemeteries and has, over the years, washed downstream into creeks, streams, rivers, lagoons, and estuaries where it finds its way to the lowest spot along the shore. Every time an aquatic creature, human swimmer, fisherman, or boat of any type, propellers or not, or tide changes, rainstorm, or wind disturbs the water even slightly, the resulting turbulence stirs up the loose muck on the bottom, clouds the water with turbidity, suspends the fines, causing this muck to be carried downstream to foul its benthos, killing millions of plants and creatures otherwise destined for the life creation process many years ahead.

Conventional wisdom of government agencies, quasi-government regulatory agencies, and lobbying groups mandate upland disposition of dredging spoils or muck. Such an approach is like trying to pump septic tank effluent to the top of a hill
and waiting for a heavy rainstorm to wash it back down. Upland disposal of muck and silt fails to secure the preservation of the living environment by ordaining the death of an entire benthos by drying and dying in the sun.

Upland disposal is obnoxious, more difficult to accomplish in more densely populated areas and certainly more costly, which drastically cuts down the number of dredging permit applicants to only those who can afford the additional expense. Whether intentionally mandated for these reasons or not, upland disposal does not help or improve or renew water bottoms or in any way assist or aid new growth of subaqueous animal and plant life. The present invention will better carry out protection and enhancement of subaqueous ecology while allowing silt and muck to be removed safely and ecologically transferable.

The present invention utilizes in situ containment tubes and bags made of porous natural or synthetic fiber cloth. These tubes allow the transfer of the muck, and benthos in the muck, to a different location underwater out of harm's way alongside sea plants, mangroves, or seawalls, under a dock or in the form of a subaqueous lagoon or baby fish hatchery or an artificial reef. Each environment provides nutrients and a continuing supply of plant and animal food to support the growth of other forms of life growing by feeding on the outer surface of porous containers.

The present invention also utilizes a muck and silt transfer system that does not destroy living matter in that it does not have any blades or other deleterious transfer devices that would harm the benthos. The system employs a submersible robotic power head which contains no moving parts or cutting edges or vanes to damage living creatures.

SUMMARY OF THE INVENTION

A method and apparatus employing low kinetic energy for transferring siltation and muck from water bottoms to safely and ecologically transfer muck and its benthos without damage thereto, permitting the growth and reproduction of all
creatures, large and small, animals, and plants living on or in the water bottoms by containing silt and muck in porous containers which ultimately may be positioned on the water bottom. The present invention allows for providing a continuous supply of nutrients and food to support the growth on the outside of the porous containers of other sea plants, crustaceans, fish, crabs, and sea animals without the danger of downstream contamination of sea grasses or clam and oyster beds or damage to boat engines, gear drives, and pumps.

The apparatus includes using a portable, submersible power head with no cutting blades, impellers, augers, centrifugal rotor, or other moving parts, which engages siltation and muck and transfers it safely without any damage to large and small animals and plants that live on the bottom.

The present invention utilizes in situ containment tubes and bags made of porous synthetic fiber cloth. These tubes allow the transfer of the benthos in the muck to a location providing more safety underwater, providing both nutrients and a continuing supply of plant and animal food to support the growth of other forms of life by feeding on the outer surface of the porous containers.

A variety of woven, spunweb, and needlepunched fiber cloths are used, depending on engineering and biological considerations, in addition to films, porous films, and membranes to achieve controlled specific gravity of the contents inside the containers. The fibers may be filled with, or coated with, heavy non-toxic minerals or compounds to increase their specific gravity to prevent their floating to the surface. The inside surface may be dusted or coated with flocculents to achieve caking and agglomeration to increase filtering efficiency and assist the dewatering process. Container fabrics may be treated on their outsides with attractants known to be especially hospitable to desirable plant and animal life.

Several unique types of flotation and inflatables to suspend the containers at water level are used, allowing them to be filled, relocated on the water surface over the underwater
location selected, and descend slowly for precise positioning on the water bottom without rupture of the tubes or their seams.

The silt and muck transfer system utilizes a portable console that includes an electric motor that can be connected to dockside electricity, an air pump driven by the electric motor, a mud and silt collection head, termed a power head, connected to the output of the air source, and optionally, a hydraulic pump. Alternate systems may employ electric generators. Also, the air blowers and water pumps may be driven directly by an engine, other power source, or a windmill, stationary or mounted on a buoy or other flotation. Further, stationary inboard and outboard engines may be modified to supply compressed air and power water pumps. The power head is positioned on the water bottom and uses air bubbles and the weight of exterior lake or ocean water to force the silt and muck under a turbidity shroud, pushing muck and silt through the discharge hose and optionally into a floating porous container where the silt and other material, living and non-living, is collected. The body of the power head may be heavily weighted, conical, with an inlet chamber and a conduit disposed therethrough that is the discharge conduit for collecting the silt, sand, and muck. Since the power head does not have any moving parts, the system does not hurt any living creatures during muck transfer. The power head may have connected adjacent thereto a plurality of water lines that are connected to the water pump disposed on the pier or dockside so that water jets are strategically aligned around the base of the power head in conjunction with an air supply that is strategically placed in a chamber inside the power head so that the entire action of the water creates a vortex and turbulence at the mouth of the discharge tube in the power head in conjunction with air bubbles to move silt, sand, and muck into the discharge hose where the air bubbles cause the muck to rise in the discharge hose to the surface for collection in a floating porous container or within a disposal area.

Once the floating container is filled with the muck and silt or sand, the container can be placed on the water bottom at
a desired location, preferably with a sturdy geotextile mat beneath it, where the container prevents further silt from being disturbed, to line the water bottom to prevent continued turbulence and movement of silt and muck on the bottom. Containers intended for use to safeguard shorelines pounded by strong wave action may be dusted and precoated inside with sand suspension agents such as sodium alginate and a preservative such as sodium nitrate or sodium nitrite. Wave action will churn the mix with the water inside the flexible containers, resulting in the sand particles becoming suspended in a thick thixotropic gel. Thus suspended in the thick gel within the container, the sandgel serves as an energy absorber which dissipates the wave energy, causing its sand to deposit in front of the shoreline.

Using the present invention allows for continuous inlet depth maintenance, beach renourishment, synthetic structural reefs for enhancing aquatic growth, and for clearing channels without resorting to upland relocation. A channel bottom can be lined with a geotextile mat for the placement thereon of containers filled with silt and muck to enhance aquatic growth while at the same time reducing turbidity, and lowering the level of deep layers of muck on water bottoms to maintain safer navigation depths in channels and berths.

Filtering containers, after filling and closure, may be transferred to, or enclosed in, a sturdy impermeable plastic film vented to a filter on the surface. Using conventional dewatering equipment and/or lowering the encased container in the water will dewater, compact, and compress the muck, increasing its density and effectiveness in compressing the muck beneath the mat on which it lays.

It is an object of this invention to provide an ecologically safe system for transferring and containing silt and muck to enhance water bottoms.

It is another object of this invention to provide an apparatus that can safely transfer silt and muck from a water bottom without damaging any living creatures on the bottom.
And yet still another object of this invention is to provide an improved ecologically safe system for removing silt and muck and to get rid of turbidity along a water bottom in which the silt and muck can be collected in containers which are placed on the water bottom for enhancing aquatic growth around them.

In accordance with these and other objects which will become apparent hereinafter, the instant invention will now be described with particular reference to the accompanying drawings.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 shows a side elevational view, partially in cross section, of the power head used in the present invention.

Figure 2 shows a side elevational view, partially in cross section, of the leaking inverted cup valve used in the power head shown in Figure 1.

Figure 3 shows a cutaway view of a power head diagrammatic drawing for power direction and control with the present invention.

Figure 4 shows a control valve used in the present invention.

Figure 5 shows in perspective and in cross section the entire system in accordance with the present invention.

Figure 5A shows a side elevational view, partially in perspective, of the operation of the present invention.

Figure 6 shows a perspective view of a reef that can be made with the present invention.

Figure 7 shows a top view of continuous depth maintenance using the present invention.

Figure 8 shows a side elevational view of the operation of the present invention using a wind generator supply.

Figures 9A, 9B, 9C, and 9D show a sequential schematic side elevational view of the operation for shoal operations.

Figure 10 shows a side elevational view of the present invention as used in a channel.
Figure 11 shows a perspective view of a movable flotation platform that includes a collecting trough to collect sand, muck, and silt, the buoyancy of which can be controlled.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The success of the present invention system and process for the non-destructive transfer of benthos is attributable to the efficient, economic performance of the invention of a submersible robotic power head which contains no moving parts or cutting edges or vanes to damage the benthos nor create turbidity.

Figure 1 illustrates the sophistication yet simplicity of the power head, the proper performance of which is based on the number and diameter of its air jets in relation to the outside circumference of the inlet nozzle and the spacing between the bottom of the inlet nozzle and the turbidity shroud. The diameter of the turbidity shroud in relation to the inlet nozzle is also important to the ability of the power head to maintain adequate negative pressure to contain turbidity.

In operation, air supplied to the air chamber bleeds through the air jets, creating a negative pressure differential inducing a rapid flow of water transferring muck and benthos up the discharge tube into a containment tube which, when filled, is floated to its predesignated position for removal, or lowered to the water bottom.

The choice of type and power of the air supply, the diameter of the discharge tube, and the depth of the turbidity shroud determine the rate of solids transfer.

Figure 2 illustrates the "leaking inverted cup valve" for raising and lowering the power head. Bleeding air into the inverted cup causes it to rise. Its top is designed as a valve which, when seated, closes off the air chamber which fills with air, causing the power head to rise. Cutting off the air supply to the inverted cup results in continued leaking of air through the dimensioned opening at the top of the cup which quickly allows it to drop, admit water to the air chamber and lower the
shroud to the bottom (generally to a different location each time because of the torque of the connecting hose lines). This up and down "cookie-cutter" action can be achieved manually or automatically without an operator using mechanical means, timers, memory chips, and control valves using available air and water pressure.

The depth to which the power head descends and is drawn down into the muck can be limited several ways, including simply attaching a line to a large enough buoy or float.

A unique method is to employ a "MuckSled" using an inflatable water tube able to float and support the weight of the power head, causing it to stay at a predetermined desired level in the muck by controlling remotely the volume and weight and therefore, the overall specific gravity of the MuckSled and the power head volume of water and air in the annular tube.

Figure 3 discloses the directional control using four water jets sourced by a water pump on the control console. These water jets face about 30 degrees toward the center and 5 degrees down. The horizontal force component of the jets make the power head move smartly in the desired direction using the invention of a directional control valve, Figure 4. For example, closing off three jets will cause the power head to "swim" in the direction opposite to the fourth jet. For simplicity, this valve allows single jet powered operation in four directions, with two jets contributing to direction control for each 90 degree quadrant. Two positions are provided for BACK or REVERSE to obviate the need to turn the valve 180 degrees. Two positions are also provided for the OFF position which diverts the water away from the four jets, as desired.

When the power head is on the water bottom and the directional valve is in the ALL ON, DIG position, the four water jets create a vortex in the direction of the coriolis force, which increases solids throughput and prevents turbidity by drawing by centripetal supply permits force the fine solids into a column below the inlet nozzle, and above the main silt column.
being forced up the discharge tube (by the pressure differential caused by the expanding air bubbles in the discharge tube).

Figures 5 and 5A show the interaction of the control console, dockside power water intake, tethered air and water line, power head with turbidity shroud, flotation and "SmarTube."

Figure 6 illustrates the use of this system for filling structural artificial reef tubes on the ocean floor, with some at substantial depths. Note that "Reefers" may be filled with inshore muck and benthos, thereby enhancing their usefulness in accelerating the growth of plant and animal life on the artificial reef. Alternatively, "Reefers" may be also filled and compacted with sand from the ocean floor with or without nutrients, attractants and other additives to create an exciting underwater environment.

"Coral Reefers" can incorporate fine copper wires in their construction for the low voltage electrolytic deposition of calcium carbonate on the surface of the reef tubes. This can also be accomplished by using metal powder filled fibers or metallized fibers.

It must be noted that artificial reefs are generally installed at depths greater than allowed for navigation channels and are designed and equipped differently to meet the special requirements of the greater depths.

Figure 7 shows the system adapted for use in inlet maintenance using wind power as an alternative power source and semi-permanent but relocatable channel markers/sand collection stations. The system will operate continuously 24 hours daily whenever the power supply permits.

As "SmarTubes" are filled, they are replaced and floated to their destination depending upon the market value of the contents.

Figure 8 shows the system in use for both continuous beach renourishment as well as filling energy absorbing "Geltubes," used for upland capture of ocean sand for beach renourishment.
Figures 9A, 9B, 9C, and 9D show an adaptation of this sand transfer invention as a "ShoalSucker" for emergency channel maintenance patrols by pontoon boats and small outboard and inboard sea craft used by the Coast Guard, Coast Guard Auxiliary, and safety patrols.

The use of these units requires on board power of 30 amps at 230 volts (a small portable generator). Alternately trolling engines may be modified to source air and/or water.

The sand transfer heads are normally locked and sealed in the UP or horizontal position and are lowered only in a shoaling emergency and at forward speeds less than 3 mph. Vanes on the power head will cause it to tilt off the bottom at high speed or if an obstruction is encountered. The "ShoalTubes" have limited capacity and include flotation and marker buoys for off-channel stowage when filled. Tow lines are included for quick use when needed to transfer life threatening shoaling in navigation channels and dangerous inlets. Smaller and larger "ShoalTubes" will be available for professional use.

There are many other uses for the sand transfer system, each of which may require special mechanical adaption for use in aquaculture, collecting golf balls, industrial sludge, cleaning the inside bottoms of storage tanks, cleaning underground conduits, restoring or creating decorative ponds, canals, streams, lagoons and lakes, and so on.

The system may use flotation tubes with adjustable buoyancy that are used to collect silt, sand, and mud from a desired water bottom area where the tubes can be floated or transported to another area and submerged. As shown in Figure 11, a pair of inflatable tubes, which can be quite sizeable in diameter and length, are inflated with air or light density liquid and may include an acrylic or Teflon® coated netting around it. The inflatable tubes may be connected together with a pair of walking boards for access and are connected by clamps to the net. A geotextile filter cloth trough underneath both of the inflatable tubes is filled with silt, muck, and sand from the power head, while the entire flotation tube floats on the
surface by the inflatable tubes and the net sling. The power head is on the bottom of the waterbed collecting silt, muck, and sand, as described herein. Air and water lines at dockside are connected to the power head which is in fluid communication with the discharge hose from the power head. Thus, materials from the bottom are transferred into the filtering container having the filter cloth. Once the materials have been filled in the filter cloth trough, then the entire flotation tube can be floated to a designated area. The trough itself may be made of a geotextile material connected under the inflatable tubes. The final filled trough may be used alone for creating a trough along a seawall, mangroves, or underwater at a desired location. The flotation tube buoyancy can be changed by adding or removing air under pressure from each floating tube which is made of rubber or plastic. The device may be submerged by adding water to each tube.

The apparatus described can remove sand, muck, and silt continuously at a fixed depth, being anchored stationary or tethered similar to channel marker buoys in an inlet, channel, lagoon, canal, or berth. The apparatus removes water, fine sand, organic matter, muck, and silt from beneath an eroding area, with the suction head submerged in water collecting some at least 4 ft. below water line at low tide and upward of 10 ft. or more from the shore line at high tide. The apparatus can also be powered for sources of air and water by a windmill directly on shore or by buoys or other flotation devices.

The present invention uses increasing specific gravity of the cloth, which filling or coating is fibrous with heavier materials or compounds to prevent the cloth from floating to the surface which might cause damage to birds or fish, or cause littering of beaches.

The geotextile container used with the flotation tube may also have thixotropic gels as suspension agents. The addition of sodium nitrate, sodium nitrite, or other anti-fungal, anti-bacterial agents to protect saccharides from degeneration may be added to the geotextile container.
The invention may include an engine to provide a source of air and water under pressure which includes a horizontal engine with two shafts with optional clutches, one driving a rotary blower or multi-stage compressor, and the other powering a water pump. A modified engine which allows one or more cylinders to pump air directly in a single shaft or takeoff to power the water pump can be used. The engine may be stationary on a boat or barge or an outboard/inboard engine which also provides propulsion at trolling speed for a skiff with several sand transfer systems for clearing inlets or a platform-style boat having one or more sand transfer systems on board mounted to the boat to maintain safe boating depth.

The flotation tube in Figure 11 may also include a tubular, inflatable bladder that contains fresh water, anti-freeze, or other fluid lighter than the ambient water which allows it to float to the surface, and having a remote control valve to control the volume and weight of the tube or bladder and a remote air valve and supply of compressed air to remove water from the tube. The system includes a means for allowing the water-filled rubber tube to support the suction head and control its weight and volume to maintain the depth of the suction head and operate at a desired level in layers of muck.

The instant invention has been shown and described herein in what is considered to be the most practical and preferred embodiment. It is recognized, however, that departures may be made therefrom within the scope of the invention and that obvious modifications will occur to a person skilled in the art.
What Is Claimed Is:

Claim 1. A method for ecologically safely transferring sand, muck, and silt from a water bottom into filtering containers for safe disposal or disposition on the water bottom, comprising the steps of:

(a) positioning a body having no moving parts adjacent a water bottom containing muck, silt, and benthos;
(b) inducing air into a muck and silt removing head;
(c) providing a discharge line from said muck and silt removing head to a surface of a body of water;
(d) collecting the silt, muck, and benthos from the water bottom in a container floating on the surface of the body of water, whereby the benthos residing in the silt and mud can be safely transferred from the water bottom to the porous container;
(e) transferring the container filled with muck, silt, and benthos to a desired location.

Claim 2. An apparatus for removing mud and silt ecologically safely from a water bottom without destroying benthos contained therein, comprising:

a source of air under pressure;

a weighted body having a large aperture disposed therethrough and a suction chamber therein;

a discharge conduit having a first end and second end, said discharge conduit first end connected to the aperture of said weighted body and connected in fluid communication with the suction chamber therein;

an air supply conduit having a first end and second end, said air supply conduit connected at said first end to said source of air under pressure and at said second end, to the suction chamber in said weighted body, said air conduit second end including a means for generating bubbles;
a filtering container connectable to the second end of said discharge conduit, whereby mud and silt can be removed by directing air under pressure into said suction chamber where it forms bubbles which rise up through the discharge conduit;

5 a source of water under pressure;

a water conduit having a first end and a second end, said water conduit first end connected to said source of water under pressure, and said second end connected, in fluid communication, to a plurality of water jet nozzles connected to said weighted body; and

10 means for controlling each of said plurality of water jets, connected between said first end and said second end of said water conduit, wherein said weighted body moves in a predetermined direction responsive to activated water jet nozzles.

Claim 3. An apparatus as in claim 2, including:

an enclosure surrounding said weighted body to reduce turbidity surrounding said weighted body, said enclosure including means for controlling vertical movement of said weighted body.

5 Claim 4. An apparatus as in claim 2, wherein said plurality of water jet nozzles equals four, said water jet nozzles positioned symmetrically around said weighted body.

Claim 5. An apparatus as in claim 2, wherein said means for controlling includes a switch, remote from said weighted body, said switch controlling the flow of said water under pressure to each of said plurality of water jet nozzles, said water jet nozzles positioned wherein said weighted body moves in a horizontal direction toward an activated water jet nozzle, or activated water jet nozzles.

Claim 6. An apparatus as in claim 4, wherein said means for controlling vertical movement is a leaking inverted cup
valve, said valve having an air chamber with means for controlling inlet air located remotely from said enclosure.

Claim 7. A buoyancy adjusting flotation device for collecting sand, muck, and silt, comprising:
means for removing sand, muck, and silt from a water bottom;
a flotation means that is inflatable;
a filter cloth trough connected to said flotation means;
a discharge hose connected to said means for removing sand, muck, and silt from said water bottom, having an input means and an output means, said output connected to said filter cloth trough whereby said filter cloth trough can collect sand, muck, and silt from said water bottom;
means for controlling the buoyancy of said flotation means; and
control means for controlling said means for collecting sand, muck, and silt whereby sand, muck, and silt can be collected in said filter trough and, through the flotation means, be positioned to a desired location.

Claim 8. An apparatus as in claim 7, including means for changing the buoyancy of said flotation means so that said filter cloth trough can be transported or submerged.

Claim 9. An apparatus as in claim 8, wherein said filter cloth trough includes a geotextile material.

Claim 10. An apparatus as in claim 9, wherein said inflation flotation device means includes a pair of inflatable tubes connected together, and a means for filling or removing said inflatable tubes with air or a liquid lighter than sea water.
Claim 11. An apparatus as described in claim 2 for removing sand, muck, and silt continuously at a fixed depth, being anchored, stationary, or tethered, similar to channel market buoys, in an inlet, channel, lagoon, anchorage, canal, or berth.

Claim 12. An apparatus as described in claim 2 for removing water, fine sand, organic matter, muck, and silt from beneath an eroding beach, with its suction head submerged in a water collecting sump 4 ft. below the water level at low tide and upward 10 ft. or more from the shore line at high tide, having perforated pipes extending radially from the sump allowing beach water to flow by gravity down to the sum for removal, preventing fluidization and erosion by wave action, and allowing the buildup of new sand to renourish the beach.

Claim 13. An apparatus as described in claim 12, having its sources of air and water under pressure powered by a windmill directly, on shore, piling, structure, buoy, or other flotation, or by or from an engine.

Claim 14. A method of enhancing the utility of geotextile filter cloth containers used in the collection, filtering, and retention of silt, muck, and sand by dusting, treating, or coating the fibers with a selection of materials which impart special physical properties to the containers including:

increasing the specific gravity of the cloth by filling or coating its fibers with heavier minerals or compounds which prevent the cloth from floating to the surface and causing damage to birds, turtles, or fish, or to the intakes or running gear of boats, or littering beaches;

improving filtering efficiency and assist in dewatering the solids by dusting or coating the inner surface with flocculents and related materials which achieve caking and agglomeration of the smaller particles; and
creating hospitable habitats on the outsides of the containers for desirable plants and animals by applying attractants, seedlings, and fertilized embryos thereto.

Claim 15. A method of enhancing the utility of sturdy, submerged geotextile containers used to safeguard shorelines by the addition of thixotropic gels as suspension agents for its sand, shells, and other materials, enabling the sandgel to prevent scouring beneath the containers by moving with the waves, thereby absorbing their energy, slowing their velocity which causes waves to drop sand, comprising:

the coating or dusting of the fabric on the inside with sodium alginites or other derivatives of kelp and seaweeds, or other environmentally acceptable materials, the ingestion or aspiration of premixed gel solutions, or the premixing of the fill material;

the addition of sodium nitrate, sodium nitrite, or other anti-fungal/anti-bacterial agents to protect the saccharides from degradation while they perform their sand-gathering function; and

allowing wave action to mix the gel forming additives and mix with sand in the container, starting on the inside of the container and proceeding throughout the entire mass, using wetting agents as needed.

Claim 16. An engine to provide a source of air and water under pressure to supply the apparatus described in claim 3, comprising:

a horizontal engine with two shafts with optional clutches, one driving a rotary blower or multi-stage compressor and the other powering a water pump; and

a modified engine which allows one or more cylinders to pump air directly and a single shaft, or takeoff, to power the water pump. The engine may be stationary, on a boat or barge, or an outboard or inboard engine which also provides propulsion at trolling speed for a skiff with several sand
transfer systems for clearing inlets, or a platform-style boat having one or more sand transfer systems on board or mounted to the boat to maintain safe boating depth in an archipelago.

Claim 17. An apparatus which allows the suction head described in claim 3, without restraining from flotation on the surface, to float in the muck on the water bottom rather than suck its way down deep, comprising:

- a tubular, inflatable bladder containing fresh water, anti-freeze, or other fluid or cellular foam lighter than the ambient water which will float to the surface, having a remote valve to control the volume and weight of the bladder, and a remote air valve and supply of compressed air to remove water form the tube; and

- means of allowing the water-filled rubber tube to support the suction head and control its weight and volume to maintain the depth of the suction head and operate at the desired level in the layers of muck.

Claim 18. A method of maintaining safe boating depth and renewing health water bottoms in waterways, having thick layers of watery muck, by lowering its level using conventional membrane dewatering techniques, aided by the increased weight of porous containers filled with solids removed from surrounding tributaries, canals, and berthing areas, after they have been dewatered, compacted, and compressed, which obviates the expense and inconvenience of conventional dredging and spoils disposal.
### INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER**

- IPC(6) : E02F 3/88
- US CL: 405/74, 37/323, 321

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

- U.S.: 405/74, 73; 37/314, 317, 320, 321, 322, 323, 119/221

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search: 04 NOVEMBER 1997

Date of mailing of the international search report: 19 DEC 1997

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