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(54) **FINE SOLIDS RECOVERY SYSTEM, METHOD AND PICK-UP WAND**

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(57) **ABSTRACT**

A fine solids recovery system including a high pressure pump and a pick-up wand that is intended to be inserted into a liquid containing fine solids therein. The system also includes a high pressure hose having one end that is in fluid communication with the high pressure pump and a second end that is in fluid communication with the pick-up wand. There is also an exhaust hose that is in fluid communication with the pick-up wand. In operation, the high pressure pump pumps liquid though the high pressure hose and into the pick-up wand to create a vacuum therein, thereby drawing up a slurry. In certain embodiments, the exhaust hose is connected to a recovery vessel, such as an oversized container, a sealed tank, or an open-top tank. The invention also relates to a method of using such a system, as well as to the details of a pick-up wand.

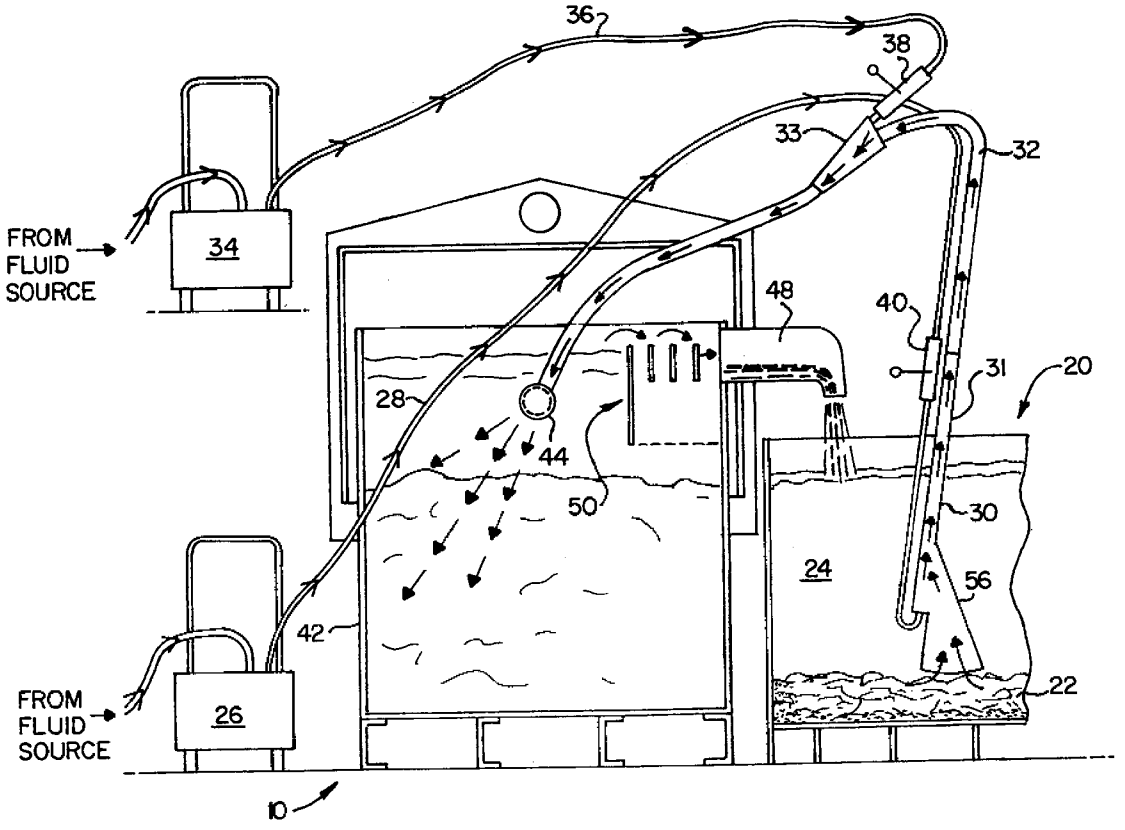
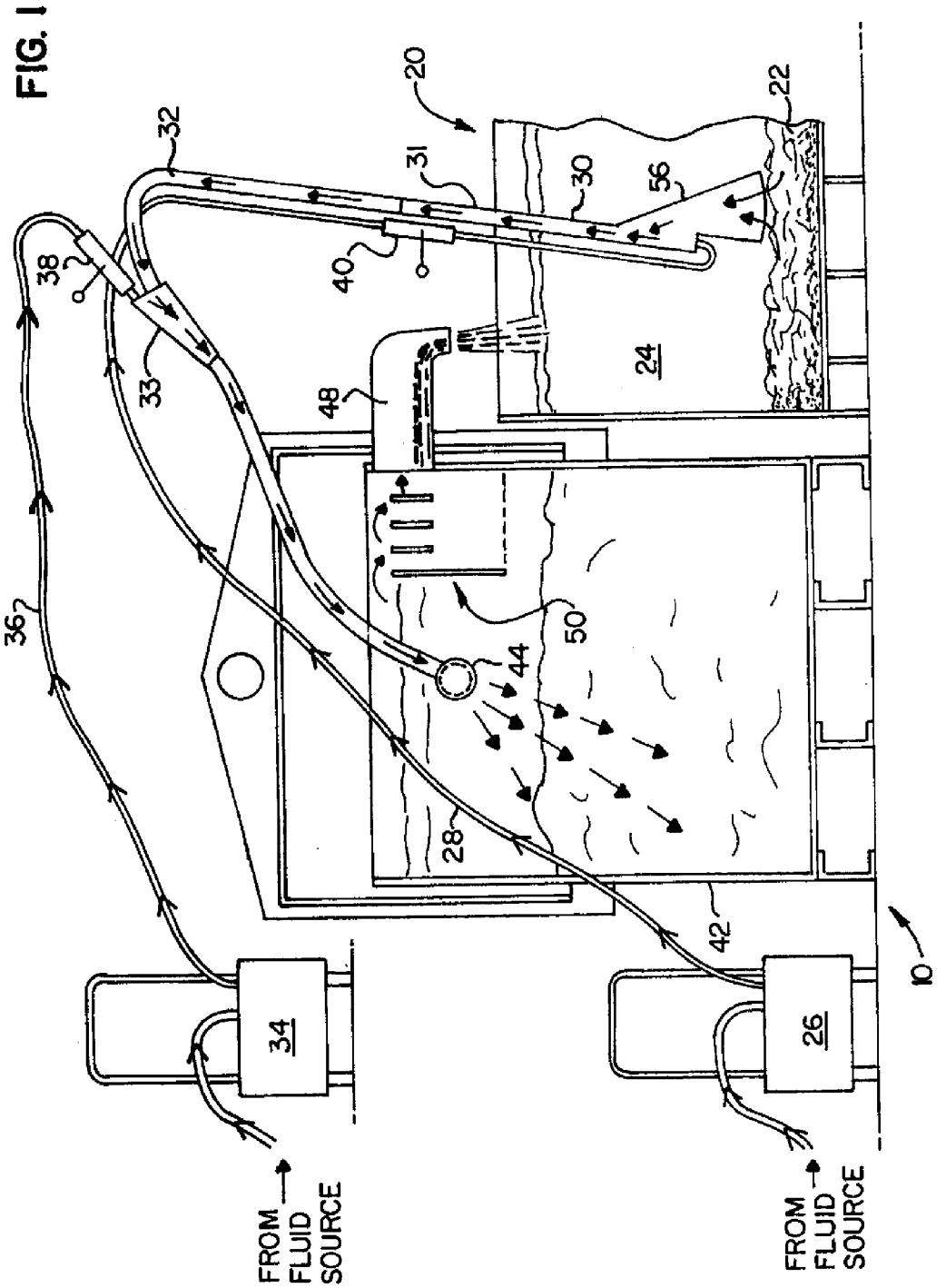


FIG. 1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FROM FLUID SOURCE

FIG. 2

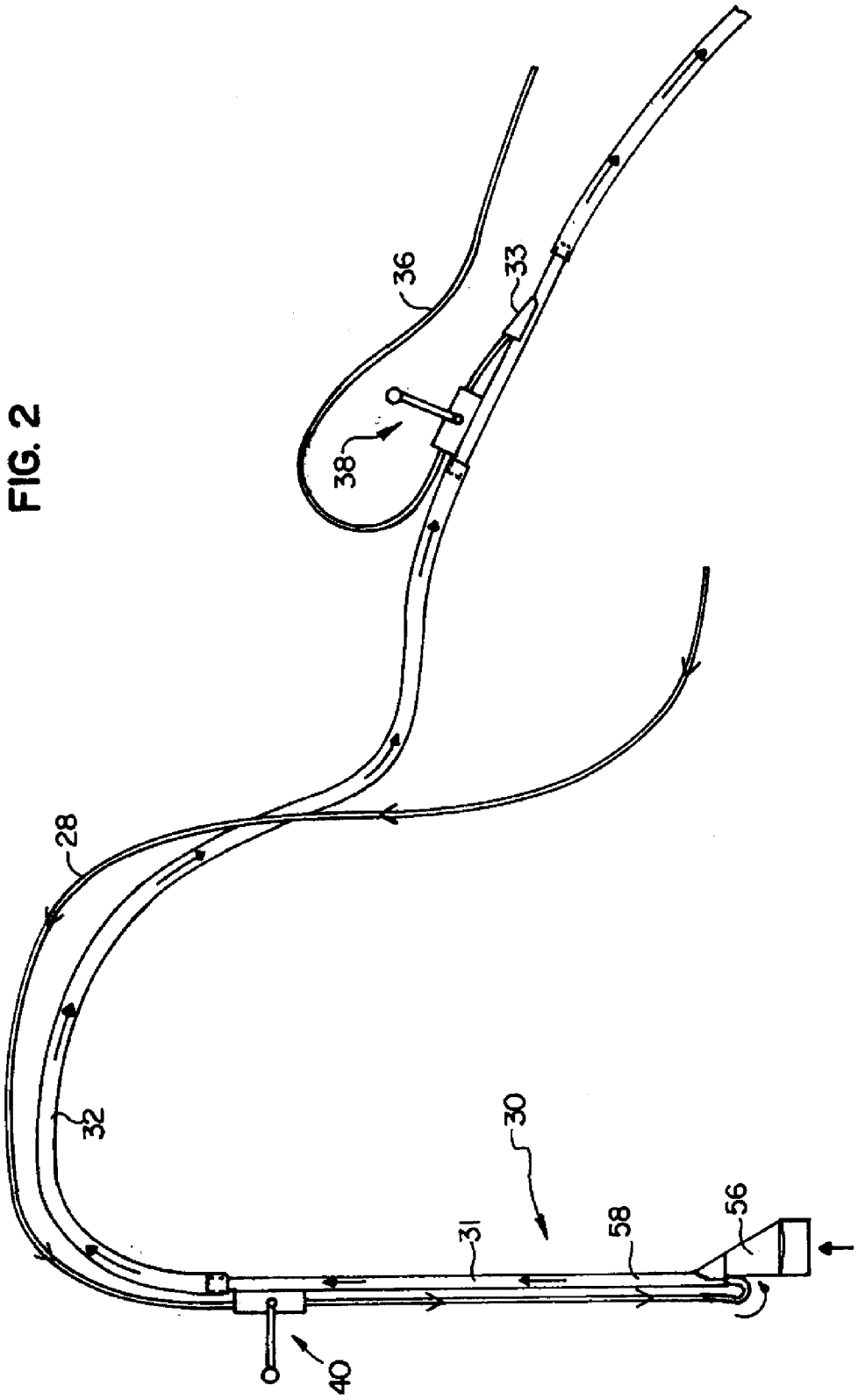
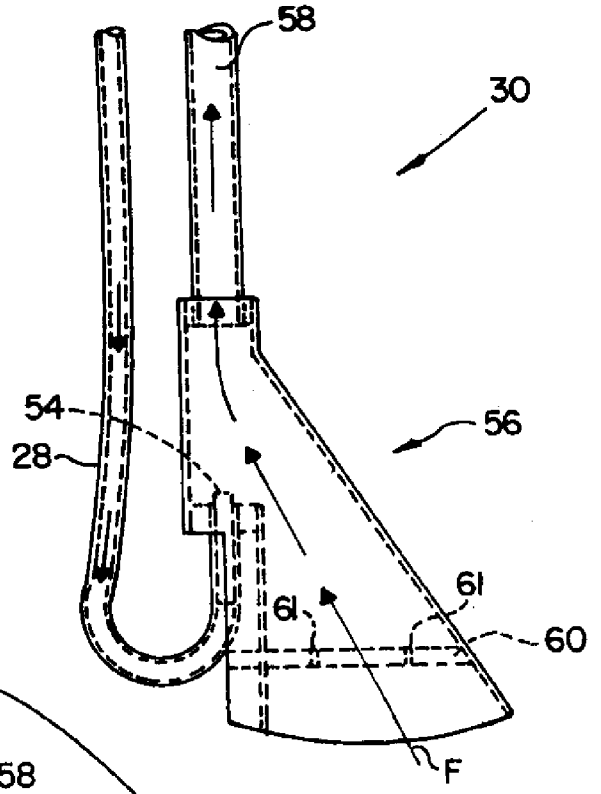


FIG. 3



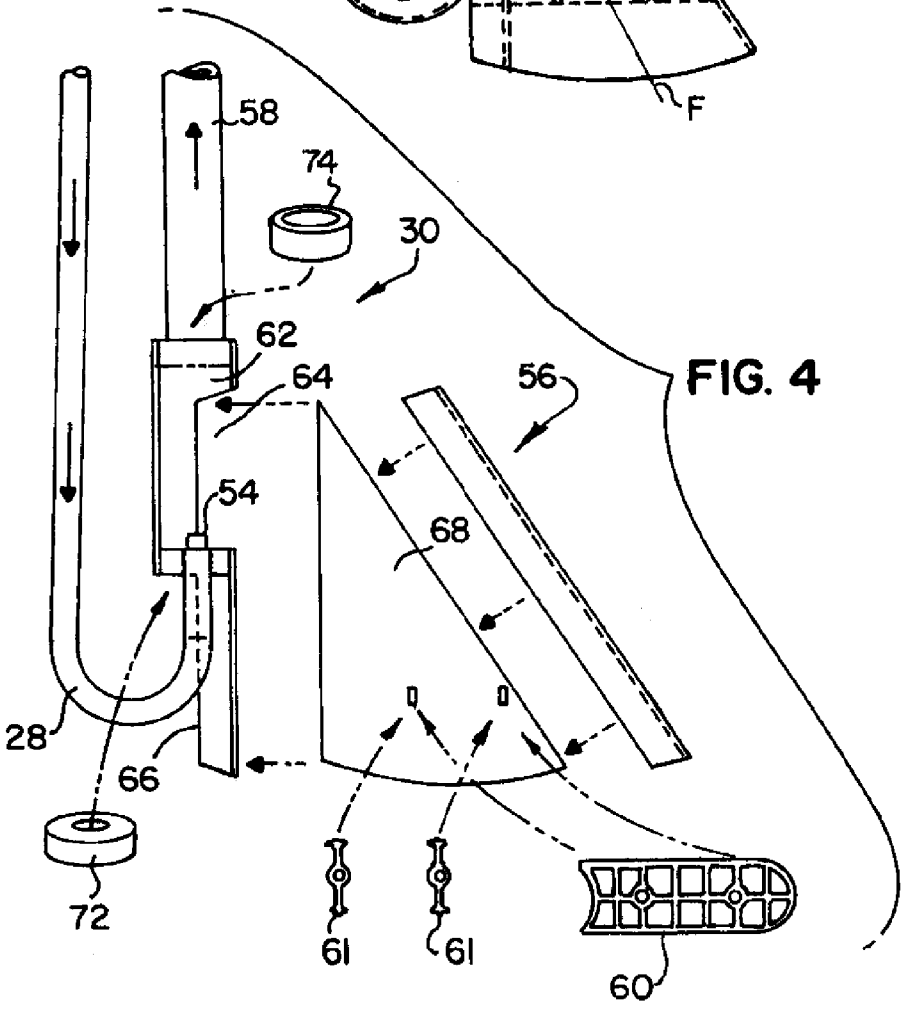


FIG. 4

FIG. 6

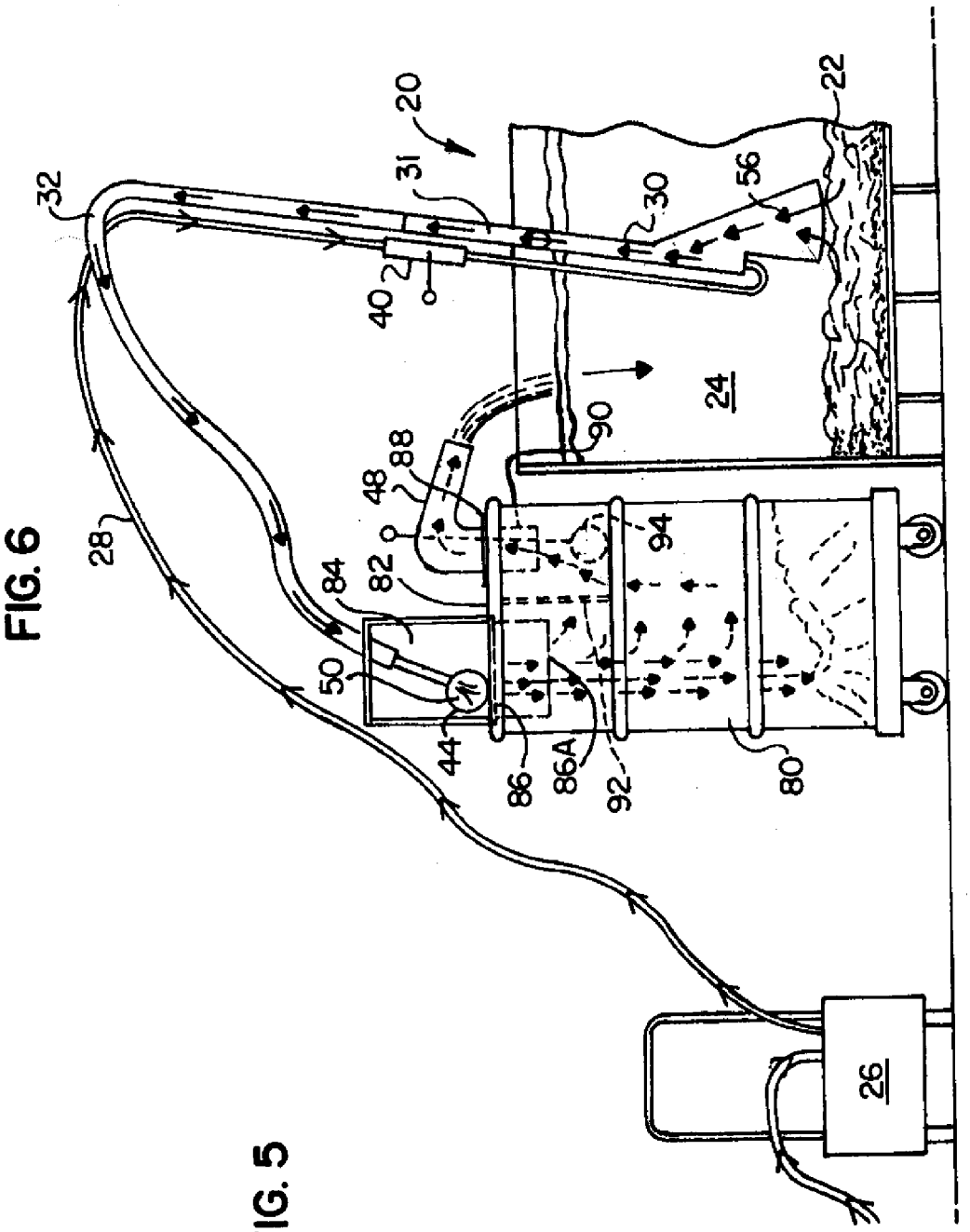

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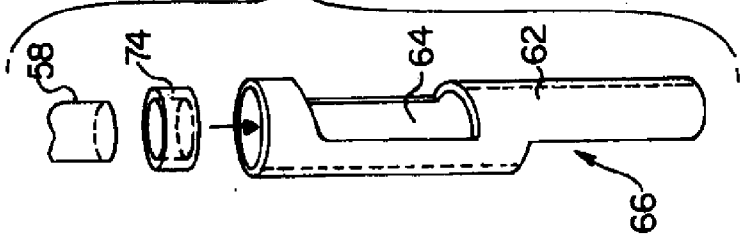
FIG. 5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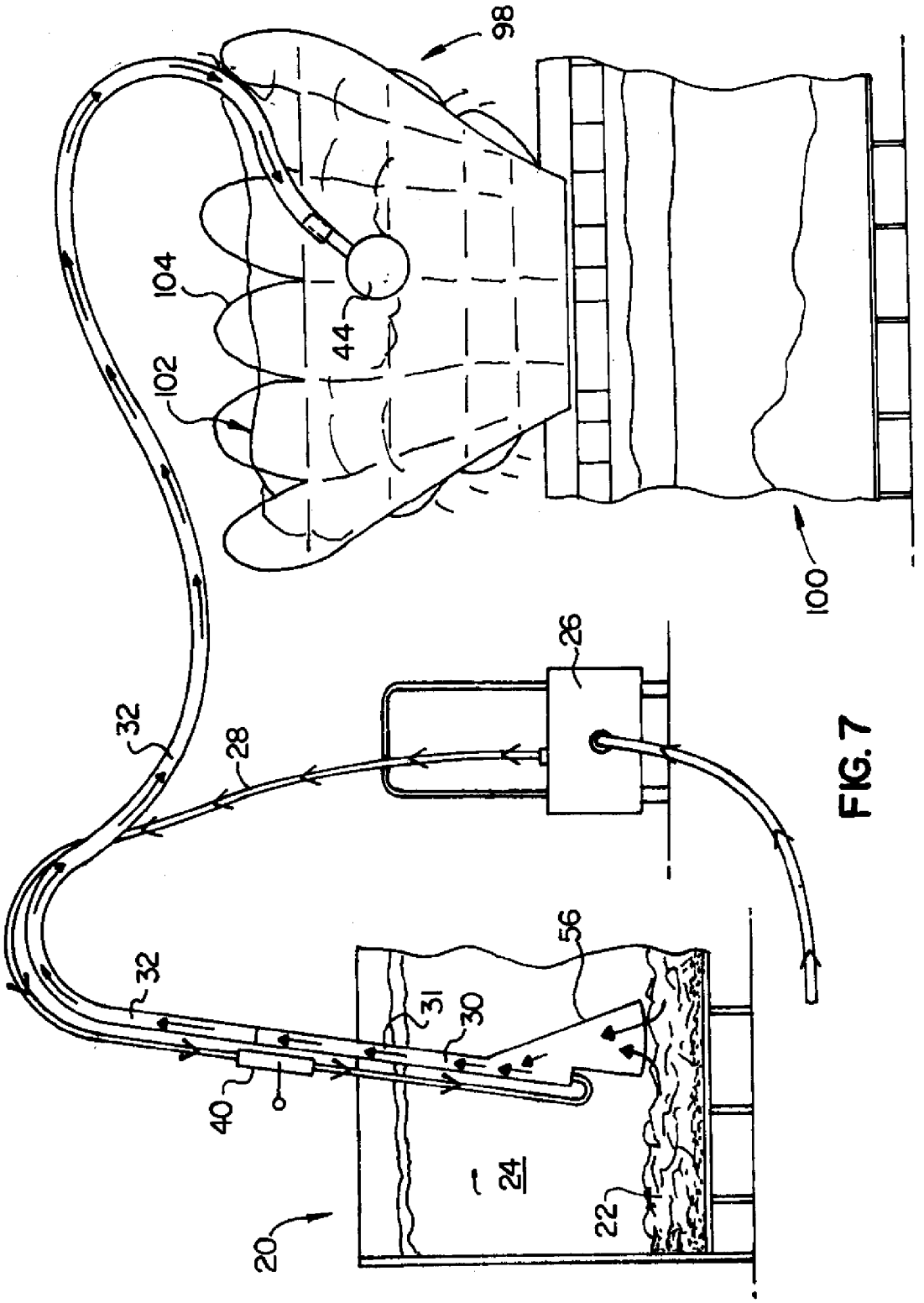

FIG. 7

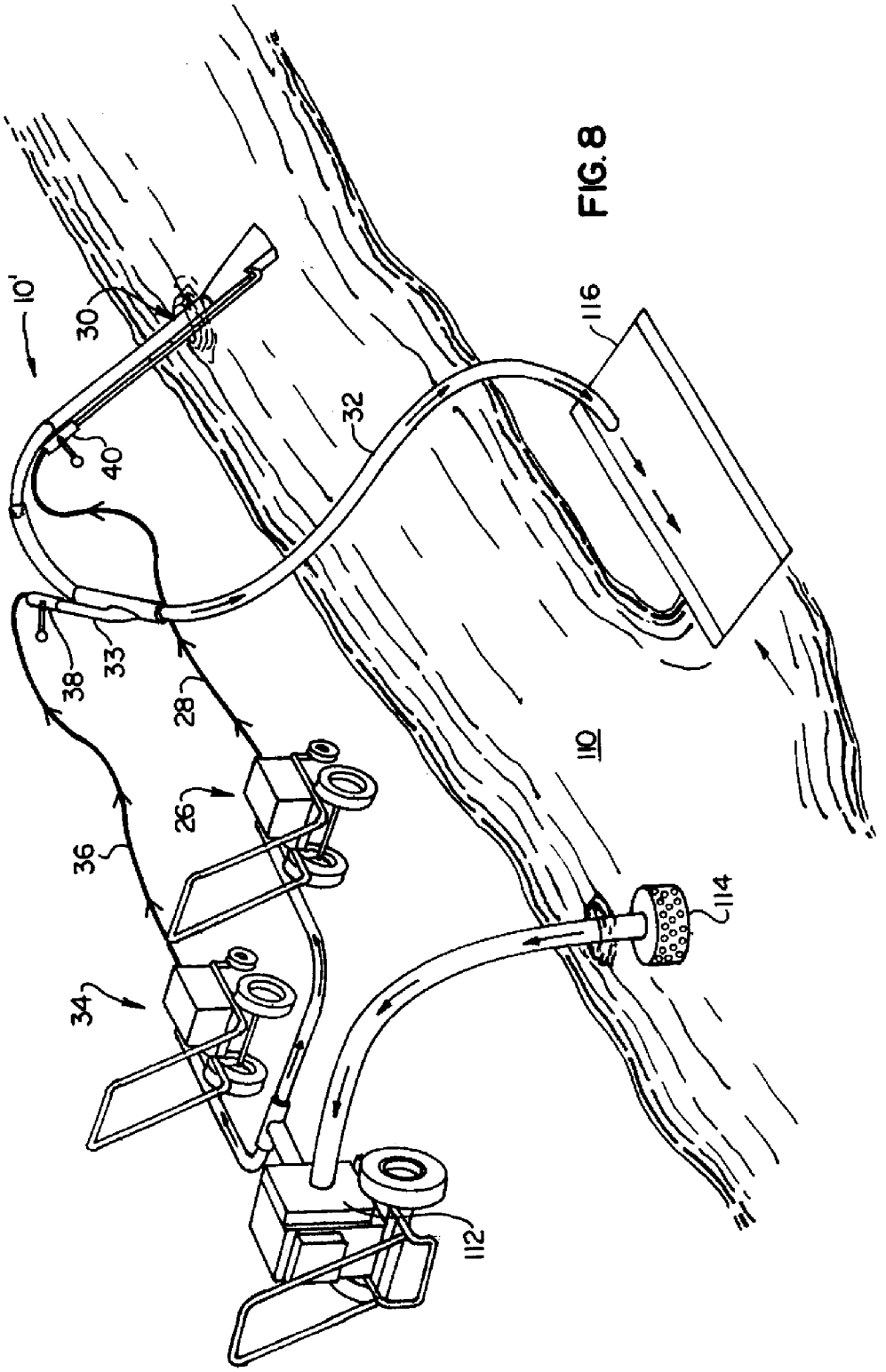

FIG. 8

FINE SOLIDS RECOVERY SYSTEM, METHOD AND PICK-UP WAND

[0001] The present invention relates generally a fine solids recovery system and to a method of recovering fine solids, as well as to a pick-up wand intended to be used to recover fine solids.

BACKGROUND OF THE INVENTION

[0002] Presently, owners and users of cutting systems that use, create or result in a spoil of sand-like media in a holding tank due to a manufacturing process find it very difficult to get the spoil (such as sand, garnet, chips, grindings, etc.) out of the holding tank. Several different types of methods for such removal (recovery) are known, such as manually shoveling the spoil, utilizing portable mechanical devices, and utilizing fixed mechanical devices that are specifically designed to be attached to the cutting system. Each of these methods will be briefly discussed below, as well as some of the drawbacks of each type of method.

[0003] Manually shoveling the spoil is one of the most basic methods of removing it from the holding tank. With the shoveling method, the manufacturing process, such as a fluid jet cutting process, needs to be interrupted when the spoil is to be removed. Prior to starting the shoveling process, the gratings normally present on top of the recovery tank need to be removed, and the water within the recovery tank normally needs to be drained or pumped out. After removing the grating and draining or pumping the water, laborers physically go into the recovery tank and shovel the spoil (such as garnet, if the application is a water jet application) into one or more waste containers. When the container(s) are filled, they are normally so heavy that they can only be moved by a fork truck, a crane, or other motorized device to a dumping area for transport to a landfill or other disposal location. After being emptied, the waste container is returned to the work area for refilling.

[0004] The shoveling method is slow and labor intensive. As mentioned above, the shoveling method normally requires the draining of the recovery tank and the removal and storage of the gratings. Further, when the spoil removal process is complete, the gratings must be reinstalled, which sometimes means welding or bolting the gratings to lock them in place. To remove the spoil, the workers must be willing to get wet and dirty, and usually boots and gloves are needed, and sometimes other protective clothing is also utilized. Depending on the material that has been processed, there can be health issues related to exposure to workers who will have a great deal of contact with the spoil. For example, in abrasive water jet operations, a basic 6 foot by 10 foot by 3 foot deep tank can contain 180 cubic feet of spoil (spent media) when full. That spoil (such as garnet) can weight well over 150 pounds per cubic foot, or over 24,000 pounds for a single unloading. Of course, larger tanks can hold much more, and smaller ones would hold less.

[0005] The spoil removal operation must be repeated on a ongoing basis, as a operational water jet with a single head and a larger jet can put, for example, between 1.00 to 1.25 pounds of garnet a minute into the tank, or as much as 75 pounds a hour, or around 600 pounds a day, or possibly 3000 pounds a week. Looking at this example, shoveling would be needed about every six to eight weeks. If this same water jet had multiple heads, the time frame between shoveling would be shortened. For example, the time between required shoveling processes with two heads might be between 3 to 4 weeks, and with three heads it could be between as little as 1½ to 2 weeks. Accordingly, it should be clear that such shoveling can easily become an expensive and time consuming process, requiring hard labor in a poor work environment where there is a likelihood of injury.

[0006] Some examples of portable powered removal methods will be discussed next. Many end users have tried various portable construction and rental tools in an attempt to make the spoil removal job easier. The time period between tank cleaning operations does not change when mechanical tools are used, but part of the method does. Users have tried: tractor mounted back hoes, excavators, clam buckets, rental vacuum trucks, and other portable mechanical devices to remove the spoil. With each of these methods, the tool must be owned or rented, the gratings need to be removed, and the tank usually needs to be drained prior to removal. Additionally, before the job is complete, hand work or shoveling is usually the last part of this process, in order to get all the spoil material out of the tank. Many tanks have supports and interior framing that often interfere with mechanical and hand removal operations. Further, when the removal process is complete, the gratings need to be replaced and affixed with bolts or welds, just as with the shoveling method.

[0007] In summary, the portable mechanical methods suffer from the following drawbacks, as well as others: (i) grating removal and reinstall is required; (ii) shut down of the cutting process is required; (iii) at least some hours of hand labor are required; (iv) there is a poor work environment with many obstacles; and (v) there is a likelihood of injury.

[0008] Finally, there are other mechanical methods that rely on devices fixed in place. Systems used in such methods are generally at the upper end, cost-wise, of the spoil recovery/removal methods. Examples of such methods include several systems that pull suspended media off the surface water of the tank water. To suspend the media, various methods are known, such as using water jets or air jets (pulsed or continuous), as well as using other methods of agitation in order to suspend the spoil, media, or garnet. Once pulled out of the tank with pumps, the solids must be separated from the liquid. The methods used vary from simple settling tanks with weirs or multiple water levels to cyclones and other devices that use centrifugal force, or other methods, to separate the solids from the liquid. There are also various simple air and electric pumps that can be affixed in the tank. These use different methods to cause the suspension of solids prior to the pumping of liquid from the tank for separation.

[0009] Some of the drawbacks of these fixed mechanical methods include the high start-up cost and the high maintenance cost due to the daily servicing required. Any recovery system break down can cause a total system shut down or mechanical failure if the spoil/garnet continues to be deposited while the recovery system is off line. Recovery systems of this type must be operated daily or in concert with the water jet or other tool that is depositing the spoil in the tank. The current state of the art in mechanical spoil removal systems varies in cost from just over $5000.00, for simple pumps, to well over $20000.00 for higher end cyclones, recyclers, and separators.

[0010] All pumps, cyclones, separators, and recyclers that pass the spoil/garnet/slurry trough their internals (impellers, diaphragms, etc.) have high wear issues. The slurry is very abrasive, and can quickly damage bearings, and wear away

impellers. If there is a break down and the systems that use in-tank jets for suspension are shut down and recovery is paused, which allows garnet build-up in the tank, the suspension jets can be buried. Once the jets are buried, the air or water orifices can become blocked, and in days the solids (media, garnet) will work their way into the jets, plugging them and rendering the same useless.

BRIEF SUMMARY OF THE INVENTION

[0011] Certain embodiments of the present invention provide a fine solids recovery system that includes a high pressure pump and a pick-up wand that is configured and arranged to be inserted into a body of liquid containing fine solids therein. The system also includes a high pressure hose having one end that is in fluid communication with the high pressure pump and a second end that is in fluid communication with the pick-up wand. There is also an exhaust hose that is in fluid communication with the pick-up wand. In operation, the high pressure pump pumps high pressure liquid though the high pressure hose and into the pick-up wand to create a vacuum within the pick-up wand, thereby drawing up a slurry of the liquid containing fine solids therein into the pick-up wand and then through the exhaust hose. In certain embodiments, the exhaust hose is connected to a recovery vessel, such as an oversized container, a sealed tank or drum, or an open-top tank or drum.

[0012] Additionally, certain embodiments of the present invention also relate to a pick-up wand. There is preferably a high pressure hose operatively connected to a source of high pressure fluid, where the high pressure hose includes an outlet end through which high pressure fluid exits. Additionally, the pick-up wand preferably includes a tube that is configured and arranged to transport a slurry mixture, and a nozzle that is connected to an inlet end of the tube. The nozzle is configured and arranged to collect a slurry mixture and to pass the slurry mixture into the tube. In use, the outlet end of the high pressure hose is positioned, with respect to the tube and the nozzle, to provide high pressure fluid into the tube, thereby creating a vacuum within the nozzle for conveying the slurry mixture through the nozzle and into the tube. Additionally, the outlet end of the high pressure hose is preferably located adjacent a bend in a flowpath of the slurry mixture through the nozzle, whereby the outlet end of the high pressure hose does not disrupt the flow of the slurry mixture through the nozzle.

[0013] Finally, the present invention also relates to a method of recovering fine solids from a fluid. Preferably, the method comprises a step of inserting a pick-up wand into a catch tank that holds a slurry of the fluid and the fine solids, wherein the pick-up wand is attached to an exhaust hose that extends between a first end that is in fluid communication with the pick-up wand and a second end that is in fluid communication with a recovery vessel. The method also includes flowing high pressure liquid through a high pressure hose and into the exhaust hose, via the pick-up wand, to create vacuum pressure within the pick-up wand. Next, the method involves drawing up the slurry, which includes some of the fine solids along with some of the fluid, from the catch tank into the pick-up wand via the vacuum pressure. Ultimately, the method involves conveying the drawn-up slurry through the exhaust hose and into the recovery vessel.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0014] Preferred embodiments of the present invention are described herein with reference to the drawings wherein:

[0015] FIG. **1** is a schematic diagram of an embodiment of the present recovery system utilizing an oversized container with a large surface area as a recovery vessel;

[0016] FIG. **2** is a schematic view of one example of a pick-up wand;

[0017] FIG. **3** shows the slurry flowpath through the pick-up wand of FIGS. **1** and **2**;

[0018] FIG. **4** is an exploded view of an embodiment of the nozzle portion of a pick-up wand;

[0019] FIG. **5** is a perspective view of the rear portion of the nozzle of FIG. **4**;

[0020] FIG. **6** is a schematic diagram of an embodiment of the present recovery system utilizing a sealed drum as a recovery vessel;

[0021] FIG. **7** is a schematic diagram of an embodiment of the present recovery system utilizing a filter within a frame seated above a recovery vessel; and

[0022] FIG. **8** is a schematic diagram showing how the present recovery system can be used as a dredging system.

DETAILED DESCRIPTION OF THE INVENTION

[0023] Embodiments of the present invention relate to a garnet, spoil, sludge and fine solids recovery system for extracting spent fines and small solids from a liquid filled holding tank or vessel, commonly referred to as a catch tank. For example, the present invention includes a system that allows the user to recover the spoil without shutting down the operations that create the waste, as the present system allows this recovery to be accomplished by working through the slots in the grating that cover many recovery tanks. Certain embodiments of the present recovery (or extraction) system include a tubular pick-up wand with an end opening, and an internal high pressure jet that is fixed near the pick-up end of the wand and directed up the wand toward the exhaust end of the wand.

[0024] Preferred embodiments of the design of the pick-up wand eliminate the need for tubing and/or jet outlets and/or other obstructions in the slurry path, because the jet stream is centered in the exhaust tube and directed towards the upper end of the pick-up wand. Preferably, certain embodiments include a flexible exhaust tube (which may be, for example, several yards long), which is attached to the upper end of the pick-up wand. The jet is preferably attached to an adjustable control valve with high pressure tubing, and the control valve is attached to a high pressure pumping source (such as a pressure washer) with a high pressure flexible hose.

[0025] Optionally, the system may also include a second jet and a second control valve, which could be used to boost the force of the slurry passing through the exhaust hose. For example, such a boost jet could be placed along the exhaust hose in a location approximately ten feet from the pick-up wand and between approximately five to ten feet from the recovery vessel. The second jet is preferably powered by a second high pressure source (such as a pressure washer), and mounted in-line with its jet direction also pointed toward the exhaust end, similar to the manner in which the primary jet is mounted. The use of additional boost jets is also contemplated.

[0026] At the exhaust end of the exhaust hose, the preferred embodiment could include an in-line diffuser, which is used to break-up the flow of the suspended garnet (or other spoil), and to aid in the settling of solids. To extract garnet, spoil, or fine solids, a recovery vessel is preferably placed on or near

the catch tank, which is to be emptied, preferably in a position where return overflow liquid can exit back into the catch tank.

[0027] Unlike many prior art systems that require the garnet, or other spoil, to be suspended in the tank water, embodiments of the present invention pull fine and small solids directly from the standing tank pile or the tank bottom. The water injected towards the exhaust end by the high pressure pump and the water pulled in by the vacuum along with the fine solids creates a heavy, flowing, spent media-rich slurry that can be controlled by the control switch to get the best flow rate to allow the solids to settle quickly when exhausted into a transport vessel. In certain embodiments, internal weirs, baffles and a diffuser also aid in getting the solids to separate and settle before overflowing the recovery vessel.

[0028] The present system, unlike some other systems, utilizes high pressure water projected up a cylinder (such as a tube), one or more optional in-line additional boost jets, a pick-up wand and a discharge hose, in combination, to move large volumes of slurry in a short time (e.g. as high as 3000 lbs/hour). The pick-up wand is preferably designed so there is no piping or jets in the flowpath of the slurry, and so the water stream that creates the vacuum points directly up a tube at a center line thereof. The pressure and flow rates are operator controlled by in-line control switche(s)/valve(s), and can be adjusted for maximum recovery. The high pressure stream creates a vacuum that allows the user to directly pick up spent media and fine solids from water filled tanks. The vacuum pulls water and the fine solids from the tank and propels it out the exhaust hose and into a transport vessel. Due to the fact the preferred embodiments of the system have no wear parts in the slurry stream, the pumps and valves only come into contact with fresh water, thereby making maintenance and operating costs very low.

[0029] Turning now to the figures, examples of certain embodiments are shown and will be described. FIG. **1** shows one example of a fine solids recovery system, which system is designated with reference numeral **10**. In this example, the fine solids being recovered will be garnet. However, as mentioned above, the present invention can be used in recovering other types of spoil as well. The garnet resulting from use is a high pressure cutting system, or other industrial device, is initially collected in a catch tank **20**. As shown in FIG. **1**, garnet **22** will generally settle out of the liquid **24** (which in this case is water) and will fall to the bottom of the catch tank **20**. Embodiments of the present invention can be used to recover the garnet by transferring to a recovery vessel where it can be reused or disposed of after being separated from any liquid extracted with it.

[0030] More specifically, in the FIG. **1** embodiment, there is a high pressure pump **26**, which may be the same type of pump used as a pressure washing device. The high pressure pump **26** receives a source of fluid, such as tap water, and pumps out the fluid at high pressure through high pressure hose **28** and to a pick-wand **30**. Thus, the high pressure hose **28** has one end that is in fluid communication with the high pressure pump **26** and a second end that is in fluid communication with the pick-up wand **30**. In the preferred embodiments, the suggested pressure range is preferably between 2500-4500 psi. However, it is contemplated that lower pressures (such as 1000 psi) or much higher pressures (such as up to 10,000 psi, or more) could also be used. Additionally, the high pressure hose **28** is preferably a flexible hose, and may be made of any type of elastomeric material.

[0031] The pick-up wand **30** includes a tube portion **31**, which is preferably relatively rigid, and which is connected to, and in fluid communication with, an inlet end of an exhaust hose **32**, which is also preferably made of a flexible material, such as an elastomer. Additional details of a sample configuration of the pick-up wand **30** will be described more fully below.

[0032] Since exhaust hose **32** will convey a slurry that could include abrasive fine solids, it may be made of a material that is more abrasion resistant than the material of the high pressure hose **28**, or it may include an inner lining of abrasion resistant material, if desired. Optionally, one or more additional high pressure line arrangements may be added, such as at V-shaped connection **33**, to provide a boosting force to help to move the slurry through the exhaust hose **32**. Such additional high pressure line arrangements are especially useful in situations where the exhaust hose is relatively long, where the exhaust hose must carry the slurry to an increased elevation, and/or where the slurry being transported is relatively thick and/or heavy.

[0033] Specifically, the FIG. **1** embodiment shows one example of the use of an additional high pressure line arrangement that includes high pressure pump **34**, which may be, for example, a pressure washing device, and which is connected to a source of fluid, such as tap water. High pressure pump **34** may be the same as high pressure pump **26**, or it may be different, such as being of a lower power.

[0034] The additional high pressure pump **34**, if utilized, is connected to a high pressure hose **36**, which is in turn connected to the exhaust hose **32** via V-shaped connection **33**. Thus, if utilized, the high pressure pump **34** pumps high pressure liquid though the high pressure hose **36**, and directly into the exhaust hose **32** at a location downstream of the pick-up wand **30**, thereby forming a boost jet for boosting the force of the flow of slurry through the exhaust hose **32**.

[0035] Preferably, there is a control switch **38** at the point where the high pressure hose **36** meets with the exhaust hose **32**. The control switch **38** is preferably configured and arranged to enable the user to turn the boost jet on or off. More preferably, the control switch is also configured and arranged to allow the user to regulate the force of the boost jet.

[0036] In addition to the control switch **38**, which is provided to regulate the boost jet, a control switch **40** may also be provided to regulate the force of the high pressure fluid entering the pick-up wand **30**. As with boost jet control switch **38**, the control switch **40** is configured to at least turn the flow of high pressure fluid entering pick-up wand **30** on and off, and more preferably the control switch **40** can also allow the user to regulate the force of the high pressure fluid entering the wand **30**. Moreover, by providing both control switches (**38** and **40**), the user can optimize the forces of the high pressure fluids in the system.

[0037] In the FIG. **1** embodiment, the outlet end of the exhaust hose **32** is positioned to deposit the slurry into an oversized tank **42**, which serves as the recovery vessel. Preferably, the outlet end of the exhaust hose **32** includes a diffuser **44**, which diffuses the slurry prior to flowing into the tank **42**, thereby breaking up the flow of garnet, or other spoil, which aids in the settling of the solids.

[0038] The tank **42** of this embodiment includes a tank exhaust pipe **48** that fluidly connects tank **42** with the catch tank **24** so that fluid can be returned to the catch tank. Preferably, there is also a weir system **50**, which includes a plurality of weir panels arranged in series, for hindering the spoil

from passing from the sealed tank **42** and back into the catch tank **24**. Other means of preventing (or at least hindering) the garnet, or other spoil, from being returned to the catch tank **24** via the tank exhaust pipe **48** are also contemplated as being within the scope of the invention, such as the use of a perforated weir or a filter.

[0039] During operation of the system, more and more slurry is deposited into sealed tank **42**, and the garnet (or other spoil) will tend to separate so that the garnet (or other spoil) settles at the bottom of the tank with the liquid located above it. Once the liquid reaches a certain height, it passes over the series of weir panels of the weir system **50**, which panels serves to remove any remaining spoil from the liquid before it passes back into to the catch tank **24**. Once the level of spoil reaches a certain height, such as the level of the weir system **50**, the spoil therein can be disposed of or recycled.

[0040] Oversize containers with large surface areas, such as tank **42** of FIG. **1**, as well as other larger tanks with built-in weirs or settling areas, when used in combination with return drains can be the most efficient way to recover large amounts of spent media if the user also has the ability handle, move and dump such very heavy, large containers. The large surface area, or the addition of several weirs or settling areas, will allow the user to use high flow rates and still achieve good settling of solids with high efficiency. With the larger tanks, a user could use one or more boost jets and/or larger wands and still achieve good settling. When full, a user will need a method to move and dump the very heavy oversize containers, some of which can weigh 5,000 to 10,000 pounds.

[0041] In addition to the manual operation described above, automated operation of one or more pick-up wands is also contemplated. For example, one or more pick-up wands could each be attached to a moving track (or other mechanism capable of moving the wands), and the system could be configured and arranged to automatically move the wand(s) along a fixed path to extract the spoil from a catch tank. Such a system could operate on a timer, or it could be triggered when the spoil reaches a certain level, or when a user manually starts the process.

[0042] One important feature of the preferred embodiments of the present invention is the manner in which the vacuum is created in the pick-up wand. Accordingly, FIGS. **2-5** have been provided to explain some additional details of one embodiment of the pick-up wand **30**. As mentioned above, the high pressure hose **28** is operatively connected to a source of high pressure fluid, such as the high pressure pump **26** (FIG. **1**). As best seen in FIGS. **3** and **4**, the high pressure hose **28** includes an outlet end **54** through which high pressure fluid exits the hose and enters a nozzle portion **56** of the pick-up wand **30**. Connected to the upper portion of the nozzle **56** is a tube **58**, which is configured and arranged to transport the slurry mixture drawn-up through the nozzle **56**. As shown in FIG. **2**, the tube **58**, which is preferably relatively rigid, is connected to the exhaust hose **32**. Further, the tube **58** also preferably extends along a straight line, and preferably has a generally circular cross-section, although other cross-sections, such as oval, and others, are also contemplated as being within the scope of the invention. Additionally, it is also contemplated that tube **58** could include one or more bent portions, instead of being completely straight. If such bent portion(s) are included, it is preferably to have them located at a point at least slightly away from nozzle **56**, so that the vacuum force created by the fluid exiting the outlet end **54** of high pressure hose **28** is maximized.

[0043] As shown in FIG. **3**, the outlet end **54** of the high pressure hose **28** is positioned, with respect to the nozzle **56** and tube **58**, to provide high pressure fluid into the tube **58**, via the nozzle **56**. Such a configuration creates a vacuum within the nozzle **56** for conveying the slurry mixture through the nozzle **56** and into the tube **58**, and then through the exhaust hose **32**. In the FIG. **3** embodiment, the outlet end **54** of the high pressure hose **28** directs the high pressure liquid along a relatively straight path that is coincident with a central axis of the tube **58**.

[0044] One important feature of this embodiment of the pick-up wand **30** is that the outlet end **54** of the high pressure hose **28** is located adjacent a bend in the flowpath F of the slurry mixture through the nozzle **56**. Accordingly, the outlet end **54** of the high pressure hose **28** is not within the flowpath, and therefore it does not disrupt the flow of the slurry mixture through the nozzle **56**.

[0045] The nozzle **56** preferably includes a screen member **60**, such as shown in the exploded view of FIG. **4**, which in this embodiment has a relatively open grid pattern. Such a screen member **60** is used to break-up large clusters of fine solids prior to entering the tube **58**, or to prevent such large clusters from passing further if they cannot be broken up. The screen **60** may be attached to the nozzle **56** by screwing it into, or otherwise attaching it to, the pair of screen attachment members **61** shown in FIG. **4**. Of course, other ways of attaching the screen to the nozzle are also contemplated, such as through the use of tabs.

[0046] FIG. **4** shows one example of how the nozzle **56** may be composed of separate pieces of metal or plastic, for example, that are adhered together in any known manner, such as with an adhesive or utilizing welding. More specifically, a nozzle rear portion **62** (also shown in FIG. **5**), may be formed of a plastic pipe, such as PVC pipe, by creating an upper cut-out portion **64** and a lower cut-out portion **66** therein. Returning now to FIG. **4**, this figure shows side pieces **68** of the nozzle **56**, which may be formed of flat plastic pieces of a generally triangular shape. As with the nozzle rear portion **62**, a front face piece **70** of the nozzle **56** may also be formed from a plastic pipe, such as PVC pipe, which in this case has been cut in half to create a semi-circular cross-section. The nozzle member **56** preferably also includes a lower ring member **72**, for securing the outlet end **54** of the high pressure hose **28** within the nozzle **56**, and an upper ring member **74** for connecting the nozzle **56** to the tube **58**. Although FIG. **4** shows how one embodiment of the nozzle **56** may be formed by modifying and connecting easily available stock parts (such as PVC piping, plastic sheets, etc.), it is also contemplated that the nozzle could be molded or cast as a single component, or as two components (such as with the screen being attached to a main body component).

[0047] The basic operation of the system of FIG. **1** will be described next. The exhaust hose **32**, which is connected to the pick-up wand **30**, is positioned so that its open end can be emptied into the recovery vessel, which in this embodiment is the oversized tank **42**. The pick-up wand **30** is placed in the catch tank **20** and positioned so the nozzle portion **56** is just above the garnet **22** (or other spent media). A fresh water supply is hooked to the high pressure pump **26** (which may be a pressure washer or other source for creating high pressure liquid). If one or more optional boost jets are used, a fresh water supply is also attached to one or more additional pressure washers (such as high pressure pump **34**), or other sources of creating high pressure fluid.

[0048] Next, the primary high pressure pump **34** is turned on with the first control switch **40** in the closed (off) position. When ready, the operator turns the first control switch **40** to the open (on) position, thereby allowing the vacuum action to start. As the slurry and fine solids begin to be picked up with the tank water, the operator allows the nozzle **56** of the pick-up wand **30** to be pulled into the spent media pile **22**. This system **10** will allow the user to adjust flow rates with the control valve **40**, and to extract high volumes of fine solids, garnet, spoil or media directly from the loaded tank **20**, without a need to agitate to suspend the material in the tank water **24**.

[0049] To aid in the recovery of especially heavy, sludge-like media or larger solids that have the ability to slow down or choke off the recovery process, the optional second jet is opened via control switch **38** to increase the flow through the exhaust hose **32**. Since the second jet is well down the exhaust hose **32**, it gives the system the added power needed to lift thicker or heavier media and to pull it through without choking or plugging. The second in-line jet, which is positioned with respect to the flowpath in a similar manner to the primary jet, creates extra vacuum, and thus eliminates the choking or flow slow down that can accumulate solids in low sections of the exhaust hose **32** and can cause plugging. Another advantage of having one or more added jets down line from first jet at the pick-up wand **30** is the increased ability to lift the spoil higher (taller head) or to transport the spoil longer distances. The two or more control switches (**38** and **40**) allow the user to adjust each high pressure pump (**34**, **26**) to get the best flow rate. The control switches **38** and **40** are adjusted to find the best flow rate that will keep solids moving in the exhaust hose **32**, and will still allow the highest percentage of solids to settle before overflowing the tank **42**. Control of the flow rates can greatly increase recovery. Operation continues as long as desired, or until the level of spoil reaches a certain height, such as the level of the weir system **50**, at which point the spoil therein can be disposed of or recycled.

[0050] Turning now to FIG. **6**, another embodiment of the present recovery system is shown and will be described. The primary difference between the system of FIG. **6** and the FIG. **1** system involves the type of recovery vessel. Accordingly, similar components to those of the FIG. **1** embodiment will use the same reference numbers, and such like components common to both embodiments need not be described again.

[0051] In the FIG. **6** embodiment, the recovery vessel is a drum **80** that has been fitted with a custom designed lid **82**. The drum **80** can be a standard 55 gallon steel drum, with no modifications, or it could be any other type of similar container. The lid **82** is preferably based on a standard lid, which, as known in the art, has a gasket (not shown) and a locking band (not shown) that can be sealed to the drum **80**. To the standard lid **82**, an intake container **84** is mounted thereon, and the intake container **84** is sealed to the lid **82**. For example, the intake container **84** could be sized similar to the size of a five gallon container.

[0052] The intake container **84** has an open bottom center portion that matches a grill plate **86** that is also attached and sealed to the drum lid **82**. The diffuser **44** and exhaust end of the exhaust hose **32** is placed through an aperture in the upper portion of the intake container **84**. The grill plate **86** has an extended sleeve **86**A that projects below the drum lid **82** for a certain distance, such as between three and six inches, for example.

[0053] Preferably, the intake container **84** is attached to the drum lid **82** in an off-center manner, near one edge of the lid. Directly opposite the container **84** is an exhaust pipe **48**, which may be in the form of an elbow. When placed next to the catch tank **20**, the exhaust elbow **48**, with its extended horizontal tube, is easy to clean and provides for splash-free recovery. The exhaust elbow **48** preferably has a flange **88** and an extended sleeve **90** that extends down through a corresponding hole in the drum lid **82**. Located between the intake container sleeve **86**A and the exhaust elbow sleeve **90**, both of which extend down into the tank **80**, there is a extended vertical perforated divider **92** that acts as a perforated weir to aid in solid recovery.

[0054] In operation, the slurry that is pumped from the catch tank **20** first impacts the in-line diffuser **44** in the intake container **84**, then it flows down through the grill plate **86** and through the extended intake container sleeve **86**A and into the bottom of the drum **80**, where the solids settle. As the drum **80** fills with water, the overflow water exits through the exhaust elbow **48** when a certain volume has accumulated. In the early stages of operation, the flowpath of the water is under the perforated weir **92**, which is a relatively long path that allows for the solids to settle. However, as the solids build up in the bottom of the drum **80**, and reach the bottom of perforated weir **92**, the flow changes direction to flow through the perforated weir **92**, where the weir prevents the solids from passing into exhaust elbow **48** (which is a relatively shorter flow path).

[0055] Optionally, there is a float **94** that hangs below the level of the drum lid **82** to let the user determine when the drum **80** is full. The user can easily learn the level of spoil in the sealed drum **80** by pushing down on a drum rod **96**. For example, the rod **96** can be several inches long, when it can only be moved an inch or so downward (because further movement is blocked by spoil), the user can tell that the drum **80** is full. When the drum **80** is full, the lid **82** on the full drum is removed and, if needed, the same lid **82** can be placed on a new drum for collecting more spoil. Using the sealed drum is a clean, low-cost way to collect spoil.

[0056] Turning now to FIG. **7**, another embodiment of the present invention is shown and will be described. The primary difference between the system of FIG. **7** and the FIG. **1** system involves the type of recovery vessel. Accordingly, similar components to those of the FIG. **1** embodiment will use the same reference numbers, and such like components common to both embodiments need not be described again.

[0057] The FIG. **7** embodiment includes a filter-type device **98** in which the spoil is separated from the liquid before the liquid enters the recovery vessel **100**. Filter-type devices can use low cost materials, such as sewn cloth or burlap bags, supported in a metal transport frame or other structure. For example, FIG. **7** shows one embodiment that includes a filter **102**, which in this example is made of a plurality of burlap bags, that is placed in frame **104**, which in this example is made of metal rods formed into a basket shape. The frame **104** is placed on top of the tank **100** where recovery is needed, and the filter **102** (i.e., the burlap bags) is placed inside the frame **104**. The end of the exhaust hose **32** (preferably with a diffuser **44** attached thereto) is placed within the filter **102**. Preferably, the filter **102** is wired shut, with the exhaust hose **32** extending out of the top.

[0058] In operation, the recovery system described above pumps the slurry into the filter **102**, the excess water drains through the burlap or other cloth, and the solids settle within

the filter. With the garnet (or other spoil) removed, the liquid flowing through the filter **102** and into vessel **100** is primarily clear water. When the filter **102** is full of spoil, the frame **104** allows for easy lifting by a crane or fork truck, and the frame/filter combination can then be transported to an area where the filter can be separated from the frame. Then, the full filter **102** can be deposited into a garbage dumpster (or other place for disposal), or for use later. Finally, the frame **104** can be returned to the use position to be filled with additional spoil after receiving as new filter.

[0059] In addition to the recovery tanks mentioned above (such as an oversized tank **42** and a sealed drum **80**), the present system may also be used with other types of recovery tanks. For example, an open-top tank or drum may also be used. Such open-top tanks are probably the simplest types of recovery vessels. One advantage of such containers is that it is easy to see when the container is full. With an open-top tank, the user simply places the drum or tank on the grate where over flow will splash back into the media tank. Because the tanks are simple, and may not do a good job of allowing solids to settle before overflow, efficiency will not be as good as with some other recovery vessels, and they will not be as clean as some other listed vessels either. The results can be improved by adding a diffuser to the exhaust hose end, as well as by adjusting the control valve to slow down the flow rate, which will aid in settling of the spoil.

[0060] Additionally, it is also contemplated that the present recovery system could be used with a recovery vessel that includes a cyclone, or other centrifugal system, for separating the spoil from the liquid in the recovery tank. Such a system would, most likely, be more expensive than some of the other systems described, but it may result in improved spoil separation, especially for very high volume users.

[0061] The present invention also has uses outside of an industrial environment. For example, since the system is relatively portable and has low initial costs, but it is still capable of creating very high vacuum with high volume water flow, the present system could be used as a specialized dredging system for mining or other applications. As one example, FIG. **8** shows how the present invention could be used for gold mining. In such a system, a diver could work the bottom of a stream to recover placer gold that is often found in areas where gold mining ceased years ago. In such environments, gold can be found buried deep in the cracks within or between rocks, where the heavy metal has settled in areas where the current is slow, such as at a bend in the stream.

[0062] More specifically, FIG. **8** shows a recovery system **10'**, which includes many of the same components as system **10** of FIG. **1** (such as high pressure pump **26**, high pressure hose **28**, pick-up wand **30**, first control switch **40**, second high pressure pump **34**, second high pressure hose **36**, and second control switch **38**). Such similar components will be numbered using the same reference numbers as in FIG. **1**, and need not be discussed here again in detail.

[0063] One difference between the system **10'** of FIG. **8** and system **10** of FIG. **1** is that in FIG. **8**, the fresh water supply for pumps **26** and **34** comes directly from stream **110** instead of from the tap. Accordingly, such water could be supplied to pumps **26** and **34** (which are preferably gas-powered) via trash pump **112**. Preferably, there is a filter **114**, or other blocking device, that prevents rocks and other debris from entering the trash pump **112**. Another difference is that in the dredging system of FIG. **8**, the outlet end of the exhaust hose is not placed in a recovery tank, but is instead directed to a sluice box **116**, where the water flow could be used to separate the gold, if present, from the lighter solids.

[0064] The system of FIG. **8** has a big advantage over many other dredging systems because the high pressure pumps **26** and **34**, in combination with the single pick-up wand **30**, creates very high vacuum pressure, which gives the system **10'** the ability to lift heavy fines and nuggets, without requiring the removal of large rocks.

[0065] Other uses of the system besides those shown and described above are also contemplated as being within the scope of the invention. For example, instead of using the off-site version of the system shown in FIG. **8** for mining metals, it could be used for filling sand bags, such as those used in emergency flooding situations. The flood waters could be used as the water source, if desired, or tap water could be used, if available. The spoil extracted could be the sand/soil from the riverbed or lakebed. Such a configuration could be very similar to that of FIG. **8**, except instead of having the exhaust hose deposit the slurry into a sluice box **116**, it would be deposited into a bag (not shown), such as the typical sandbags made of burlap or polypropylene (as long as the polypropylene is somewhat porous, to allow for the spoil to be separated from the liquid). The bag material would then act ad the filter, allowing the fluid to pass through while retaining the sand/soil therein. The filed sandbags could then be stacked or other wise used in any known manner for flood control or other desired use. Such as system is much easier than manually filling the sandbags, and provides an efficient, effective, on-site way of creating sandbags at the location where they are to be used.

[0066] While various embodiments of the present invention have been shown and described, it should be understood that other modifications, substitutions and alternatives may be apparent to one of ordinary skill in the art. Such modifications, substitutions and alternatives can be made without departing from the spirit and scope of the invention, which should be determined from the appended claims.

[0067] Various features of the invention are set forth in the appended claims.

What is claimed is:

1. A fine solids recovery system comprising;

a high pressure pump;

a pick-up wand configured and arranged to be inserted into a body of liquid containing fine solids therein;

a high pressure hose having one end that is in fluid communication with said high pressure pump and a second end that is in fluid communication with said pick-up wand; and

an exhaust hose that is in fluid communication with said pick-up wand,

wherein said high pressure pump pumps high pressure liquid though said high pressure hose and into said pick-up wand to create a vacuum within said pick-up wand, thereby drawing up a slurry of the liquid containing fine solids therein into said pick-up wand and then through said exhaust hose.

2. The fine solids recovery system according to claim **1**, wherein said high pressure liquid is water at a pressure within a range of approximately 2500 to 4500 psi.

3. The fine solids recovery system according to claim **1**, further comprising:

a second high pressure pump; and

a second high pressure hose attached to said second high pressure pump,

wherein said second high pressure pump pumps high pressure liquid though said second high pressure hose and directly into said exhaust hose at a location downstream of said pick-up wand, thereby boosting the force of the flow of slurry through said exhaust hose.

4. The fine solids recovery system according to claim **1**, further comprising a recovery vessel that is in fluid connection with an outlet end of said exhaust hose.

5. The fine solids recovery system according to claim **4**, wherein said recovery vessel includes a filter for separating the fine solids from the slurry.

6. The solids recovery system according to claim **1**, further comprising:

a wire basket;

a cloth filter seated within said wire basket, said cloth filter being configured and arranged to separate fine solid from the slurry;

a recovery vessel that is in fluid communication with an outlet end of said exhaust hose, whereby the slurry passes from said exhaust hose, through said cloth filter wherein the fine solids are captured, and into said recovery vessel.

7. The fine solids recovery system according to claim **4**, wherein said recovery vessel comprises:

a tank;

a tank exhaust pipe that fluidly connects said tank and the body of liquid; and

a weir system for hindering fine solids from passing from said tank into said tank exhaust pipe.

8. The fine solids recovery system according to claim **7**, wherein said weir system includes a perforated weir.

9. The fine solids recovery system according to claim **7**, wherein said weir system is comprised of a plurality of weir panels arranged in series.

10. The fine solids recovery system according to claim **1**, further comprising:

a trash pump that is configured and arranged to receive low pressure liquid from a stream though a low pressure hose; and

a sluice table,

wherein:

said high pressure pump is configured and arranged to receive low pressure liquid from said trash pump through an intermediate hose;

said pick-up wand is configured and arranged to draw up slurry from the same stream that said trash pump receives liquid from; and

said exhaust hose includes an outlet that directs the slurry toward said sluice table.

11. A method of recovering fine solids from a fluid, the method comprising the following steps:

inserting a pick-up wand into a catch tank that holds a slurry of the fluid and the fine solids, wherein the pick-up wand is attached to an exhaust hose that extends between a first end that is in fluid communication with the pick-up wand and a second end that is in fluid communication with a recovery vessel;

flowing high pressure liquid through a high pressure hose and into the exhaust hose, via the pick-up wand, to create vacuum pressure within the pick-up wand;

drawing up the slurry, which includes some of the fine solids along with some of the fluid, from the catch tank into the pick-up wand via the vacuum pressure; and

conveying the drawn-up slurry through the exhaust hose and into the recovery vessel.

12. The method according to claim **11**, wherein during said step of flowing high pressure liquid to create pressure within the pick-up wand, the high pressure liquid is directed in an axial direction of a tube portion of the pick-up wand, but without having any portion of any piping that conveys the high pressure liquid to the pick-up wand disrupt the flow of the slurry through the pick-up wand.

13. The method according to claim **11**, wherein during said step of flowing high pressure liquid to create pressure within the pick-up wand, the high pressure liquid is directed in an axial direction of a tube portion of the pick-up wand, as well as being directed into a central portion of the tube.

14. The method according to claim **11**, further comprising a step of flowing high pressure liquid through a second high pressure hose and into a portion of the exhaust hose at a location downstream of the pick-up wand, thereby boosting the force of the flow of slurry through the exhaust hose.

15. A pick-up wand comprising:

a high pressure hose operatively connected to a source of high pressure fluid, said high pressure hose including an outlet end through which high pressure fluid exits said high pressure hose;

a tube configured and arranged to transport a slurry mixture; and

a nozzle connected to an inlet end of said tube, said nozzle being configured and arranged to collect a slurry mixture and to pass said slurry mixture into said tube;

wherein said outlet end of said high pressure hose is positioned, with respect to said tube and said nozzle, to provide high pressure fluid into said tube, thereby creating a vacuum within said nozzle for conveying the slurry mixture through said nozzle and into said tube, and

further wherein said outlet end of said high pressure hose is located adjacent a bend in a flowpath of the slurry mixture through said nozzle, whereby said outlet end of said high pressure hose does not disrupt the flow of the slurry mixture through said nozzle.

16. The pick-up wand according to claim **15**, wherein said tube is relatively rigid, and extends along a straight line, and further wherein said tube is configured and arranged to attached to a relatively flexible exhaust hose.

17. The pick-up wand according to claim **16**, wherein said outlet end of said high pressure hose directs the high pressure liquid along a relatively straight path coincident with a central axis of said tube.

18. The pick-up wand according to claim **15**, further comprising a screen positioned within said nozzle.

19. The pick-up wand according to claim **15**, further comprising a control valve attached to said tube, wherein said control valve is configured and arranged to turn the flow of high pressure fluid on and off.

20. The pick-up wand according to claim **15**, wherein the high pressure fluid is water.

21. The method according to claim **11**, wherein:

the recovery vessel used during said conveying step is a sandbag; and

the catch tank used during said inserting step is one of a river or lake.

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