

Oct. 20, 1964

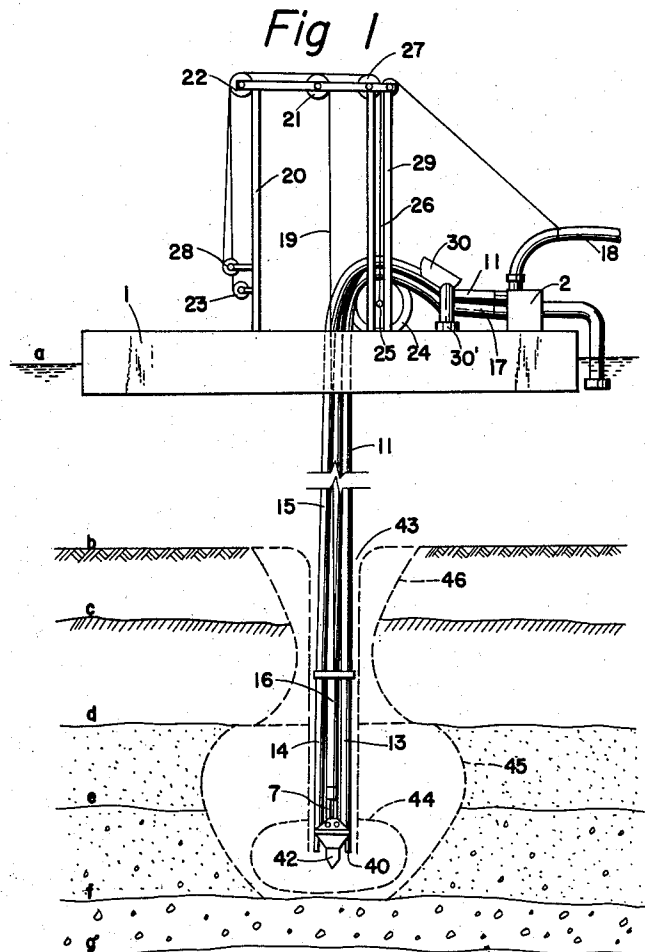
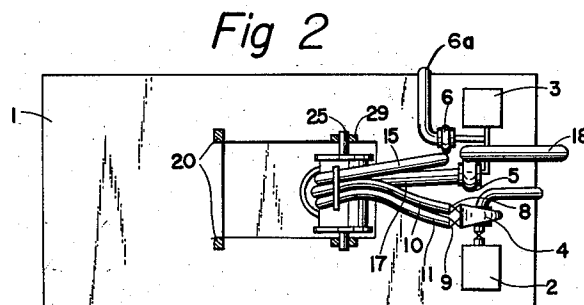
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3,153,290

APPARATUS FOR SUBAQUEOUS EXCAVATIONS

Filed Jan. 30, 1962

4 Sheets-Sheet 1



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APPARATUS FOR SUBAQUEOUS EXCAVATIONS

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Fig. 3

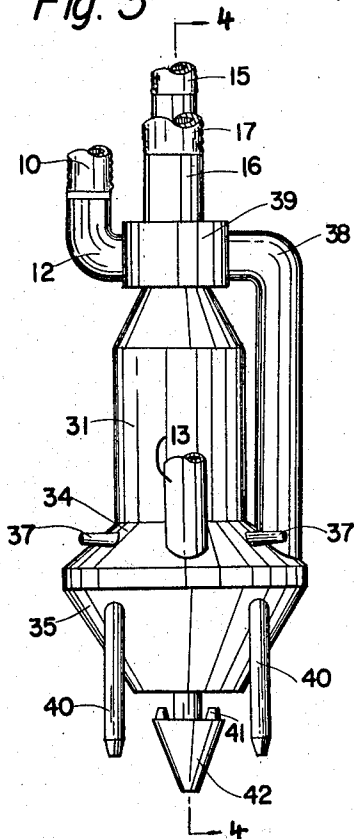


Fig. 4

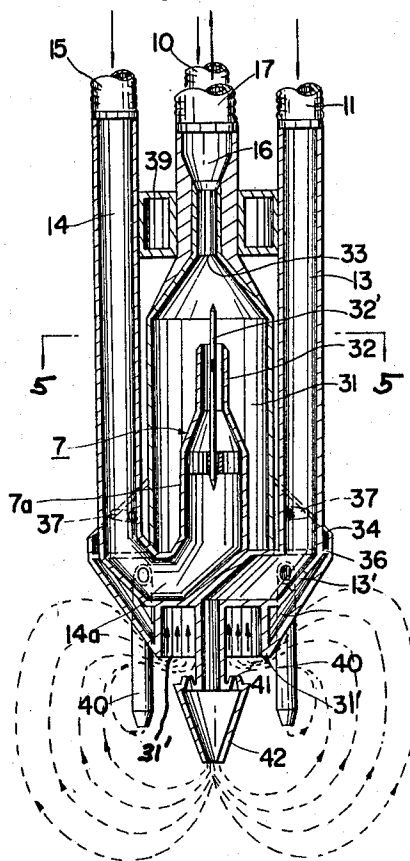
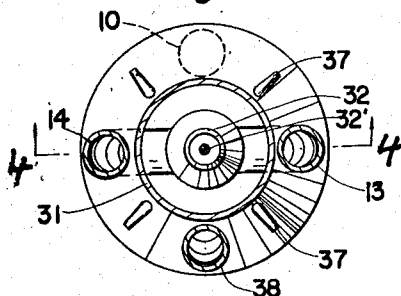


Fig. 5



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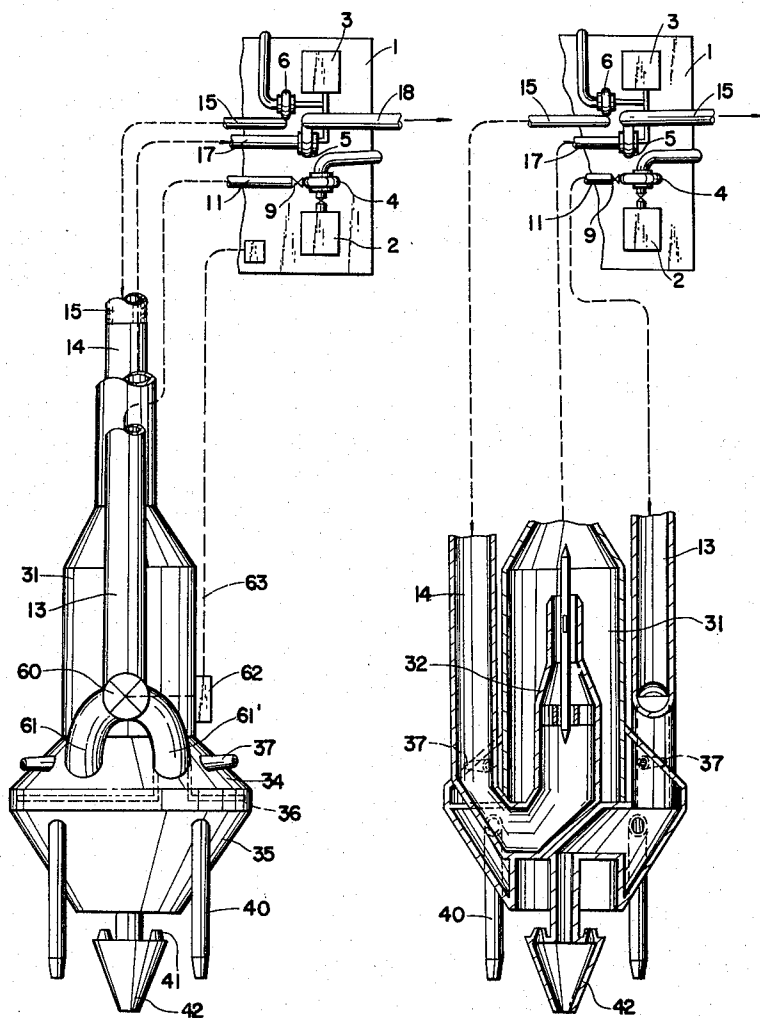
APPARATUS FOR SUBAQUEOUS EXCAVATIONS

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Fig. 6

Fig. 7



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APPARATUS FOR SUBAQUEOUS EXCAVATIONS

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4 Sheets-Sheet 4

Fig. 8

Fig. 9

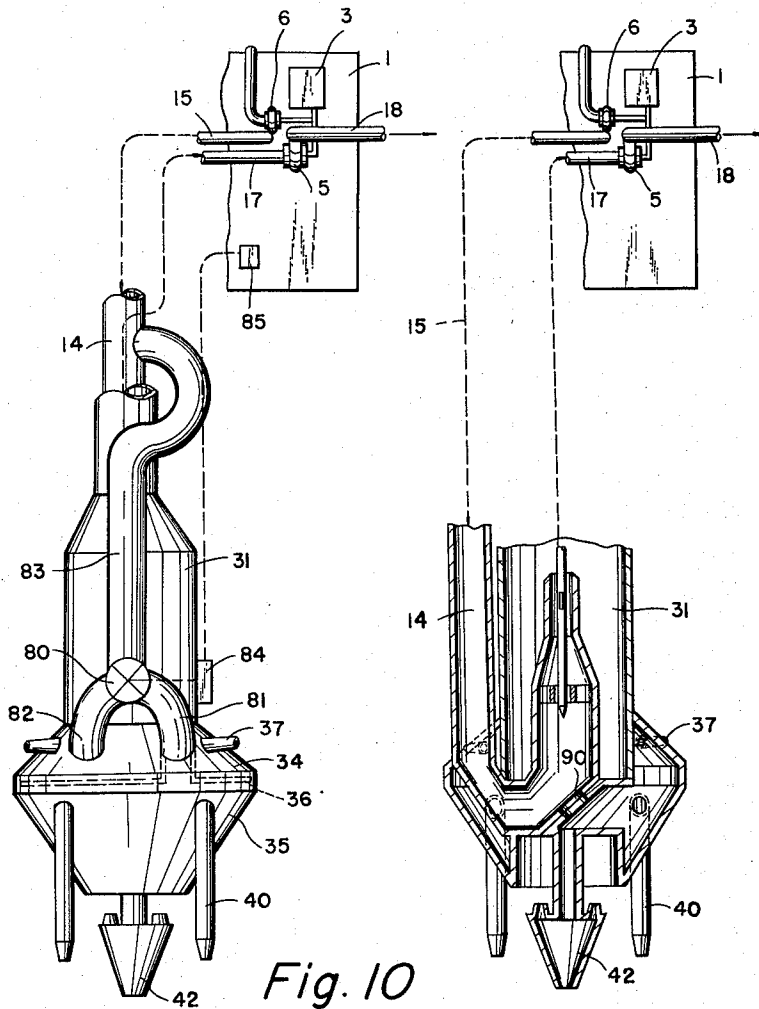
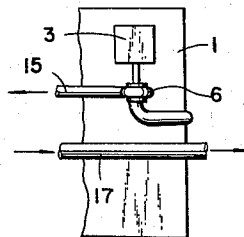


Fig. 10



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3,153,290
APPARATUS FOR SUBAQUEOUS EXCAVATIONS
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This invention relates to an apparatus for collecting sand and gravel from a gravel layer existing at the lower part of a soil layer beneath the water.

Sand and pebbles are used in large quantities as materials for a concrete mix. Also, they have been much used recently in the formation of land, especially in the formation of land by reclamation, because in land formed of sand and pebbles the ground is firm, sinks little and has good drainage, as compared with land formed of soil and mud. So far, sand and pebbles have been collected mainly from the areas along the middle or upper stream of rivers and, therefore, the deposits of sand and pebbles in the vicinity of the towns and cities have been almost depleted. Therefore, the deposits of sand and pebbles are gradually becoming accessible from ever-increasing distances and, accordingly, considerable expense is required for transportation. In the reclamation of land along the seashores there is a great demand for vast quantities of sand and pebbles. There is, therefore, a pressing need to establish a method for economically collecting sand and pebbles in large quantities for use as materials for concrete or for reclamation.

One means of solving this problem is the collection of sand and pebbles existing under the Quaternary stratum. The Quaternary stratum usually has a sand layer or a gravel layer of several to ten-odd meters in thickness at the lower part of the soil layer. Therefore, after the removal of the surface soil, the sand or pebbles existing in the lower layer thereof becomes an almost inexhaustible mine of sand and pebbles. After collection by this method, the land turns into a hollow or a pond and remains unusable and, therefore, it itself requires reclamation. The assumption is that under normal circumstances this Quaternary stratum is connected to some extent to the bottom of the sea, and that at the bottom of the sea near the shore, though perhaps sometimes not linked directly to the Quaternary stratum, there usually exists a layer of gravel which has been washed down the rivers. When such a gravel layer exists at the bottom of the sea, it is desirable to collect sand and pebbles therefrom with the advantage that by such collection a dredging operation is also performed. This assumption is confirmed by geological investigation of the sea-bottom strata at various test spots beneath the water near the seashore of Quaternary stratum and beneath the water near the coast in the vicinity of the rivers. As an example, a cross-section of the sea-bottom stratum found situated 1,200 m. offshore from Kobe Steel Co., Ltd., city of Kobe Japan, is illustrated at the lower part of FIG. 1, and its details are as given below:

Items	Thickness (m)	Symbol
Depth of Water (from the bottom of the water to the surface thereof).....	12.0	a b
1st Layer (mud, silt layer).....	5.0	b c
3rd Layer (hard shell clay mix layer).....	6.0	c d
Gravel Layer:		
Material Layer (fine, medium, coarse sand mix layer).....	5.0	d e
Material Layer (pebble coarse sand mix layer).....	5.0	e f
Material Layer (small pebble layer).....	5.0	f g

In order to collect the most desirable layer (the d-e-f-g layer), the undesirable b-c-d layer must first be re-

moved. This removal, and removal from the bed of a body of water, amounts to wasteful labor and expense. When the c-d layer consists of hard clay, it is very difficult, expensive and impractical to remove it with the existing machinery of the prior art.

This invention has for its primary object the use of a simple apparatus, permitting the removal of only a minimum of the b-c-d layer and collection of material from the d-e-f-g layer in large quantities.

Another object of the present invention is to provide a hydraulic dredging apparatus having a substantially streamlined configuration, wherein various hydraulic passages are specifically arranged so as to provide the physical configuration necessary therefor.

Another object of the invention is to provide a hydraulic dredging apparatus of the kind referred to above, which comprises an efficient hydraulic lifter having an efficient means for correctly guiding and establishing a hollow jet stream through and at least over a distance therefrom, so as to increase substantially the sucking efficiency of the jet over the prior art.

Another object of the invention is to provide a hydraulic dredging apparatus of the above kind, wherein the hydraulic lifter has a wide suction inlet at the bottom, whereby maximum possible efficiency is attained for the collection of the granulated mineral material.

Another object of the invention is to provide a hydraulic dredging apparatus of the above kind, wherein the material intake performance of the hydraulic lifter is considerably increased by the provision of a plurality of upwardly-directed auxiliary nozzles, which are united physically with a conventional main central boring nozzle.

Still another object of the present invention is to provide novel means for guiding a group of flexible tubes leading from a plurality of rotary pumps on board a floating vessel.

Further objects and advantages of the invention will become apparent from the following specification, claims and drawings.

For the purposes of the present invention, the apparatus comprises a jet pump having a jet-pump nozzle, a downward nozzle for shaving and a horizontal nozzle for cutting, a floating operation deck having a pump for feeding water to said nozzles, a flexible pipe connecting said nozzles to said jet pump, and a means provided on the floating operation deck capable of moving said jet pump up and down, and means to operate it so as to permit lowering of said jet pump from the floating operation deck to the bottom of the water, passing it through the soil layer quickly and together with the downward nozzle, until the jet pump itself reaches the gravel layer. There the velocity of the pump's descent is stopped or decreased, simultaneously permitting the horizontal nozzle and the pump itself to interact in the collection of sand and pebbles.

Thus, as the collection of sand and pebbles is carried out by the jet pump, the apparatus is relatively simple as compared to a scraper and other machinery of the prior art. Also, it is possible to collect easily sand and pebbles existing even in deep places. Further, the provision of a downwardly directed nozzle for shaving and of a horizontal nozzle for cutting permits the jet pump to pass through the soil layer, to cut the gravel layer easily. Moreover, when the soil layer is shaved and material collected leaving the bottom in the shape of a flask, as shown with a dotted line at the lower part of FIG. 1, the pressure generated by the nozzles prevents the soil layer from collapsing by keeping the seawater from flowing in through the neck of the flask-like cavity. The jet-pump, as well as the shaving and cutting nozzles, are connected with the pump on the floating operation deck by means of a flexible pipe and thus it becomes easy to

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move the jet pump up and down. This invention is based on the discovery that the *c-d* layer forming the lower part of the soil layer usually is a hard layer, very resistant to pressure, and this fact in combination with the characteristics of a jet pump contributes to the inventive solution of the problems on hand.

Further details are explained by reference to the accompanying drawings, in which:

FIGURE 1 is an elevational view of a floating dredger embodying the principles of the present invention in field operation with several earth layers;

FIGURE 2 is a top plan view of the floating dredger, with a winch or derrick tower fixedly mounted on board, substantially broken away;

FIGURE 3 is an elevational view of a hydraulic lifter and cutter assembly;

FIGURE 4 is a longitudinal sectional view of the assembly taken on the plane 4—4 in FIGURES 3 and 5, respectively;

FIGURE 5 is a cross-sectional view of the assembly taken on the plane 5—5 in FIGURE 4;

FIGURE 6 is an elevational view of an alternative embodiment of the lifter and cutter assembly, and a top plan view of a part of the floating vessel on a reduced scale, hydraulic and other connections therebetween being shown diagrammatically by dotted lines;

FIGURE 7 is a view similar to that of FIGURE 6 in another alternative of the invention and is shown in its longitudinal section;

FIGURE 8 is a view similar to that of FIGURE 6, showing yet another embodiment of the invention;

FIGURE 9 is a view similar to that of FIGURE 7, showing yet another embodiment of the invention;

FIGURE 10 is a top plan view of part of a floating vessel, illustrative of a modified arrangement of the invention.

Referring now to the drawings, FIGURES 1-5, a floating station 1, such as a floating vessel or vehicle, mounts prime movers 2 and 3, such as electric motors, internal combustion engines or the like, which are, however, shown diagrammatically in the form of cubes for simplicity of the drawing. Hydraulic pumps 4, 5 and 6 preferably of the rotary type as shown are mounted on board vessel 1, of which that denoted by 4 is direct-coupled to motor 2 and those denoted by 5 and 6 are operatively connected with motor 3 for being driven thereby through suitable gearings not shown. A suction pipe 6a leads from the suction side of pump 6 to a suitable depth below water level *a*, although the submerged inlet of the pipe is not shown. The delivery side of pump 6 is hydraulically connected through both flexible tube 15 and rigid steel pipe 14 or other suitable conduit means to the nozzle 32 of a jet lifter generally denoted by 7. For a smooth connection between the bottom end of depending pipe 14 and that of the upward-directing nozzle casing 7a, a substantially U-shaped connection 14a is provided as most clearly seen from FIGURE 4. A pencil rod 32' with its both ends pointed sharply as shown extends centrally through the reduced nozzle end and projects upwardly thereof a considerable distance. The rod 32' which may be called "core rod" serves effectively to guide the jet stream, when the machine operates, and assures the formation of a hollow jet within a considerable distance above the jet outlet so as to increase both the cross-sectional area of jet and the flow velocity thereof, thus substantially improving the suction effect of the jet lifter. Jet lifter 7 comprises further a dome casing 31, which opens at its upper end substantially to a full extent and is reduced at its upper part as at 33 to form a throat or Venturi tube in registration at a certain distance with the outlet end of nozzle 32. Throat 33 is in direct communication with outlet 16 formed at the upper extreme end of dome 31 for reception of the lower end of a flexible tube 17, which leads to the suction side of rotary pump 5.

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The pump 5 acts thus as a jet lifter booster pump and is called frequently "sand pump." As shown, the aforementioned U-connection 14a passes through the wall of dome 31 at its relatively low part. Discharge pipe 18 leads from the discharge side of sand pump 5 to a remote place, not shown, where the dredged material and the conveying medium or water should be discharged.

The delivery side of pump 4 is divided into two passages, which are provided with valves 8 and 9, respectively, one of said valves 9 in connected, on the one hand, through flexible tube 11 and a rigid steel pipe 13 with a downward-directing nozzle 42, which is provided along the lower extension of central axis of nozzle 32 in an opposite manner, and, on the other and, through the intermediary of an opening 13' with a lower circular chamber or casing 35 formed so as to surround the lower outside wall of dome 31. The body of nozzle 42 is shaped substantially into an inverted cone for generating a downwardly directed jet adapted to provide central boring as in the conventional technique, yet provided with a plurality of upwardly directed nozzles 41 for accelerating the action of lifter 7. Circular chamber 35 is provided with a plurality of downwardly directed nozzles 40 for generating cutting jets over enough area for sinking the dredging assembly so far described.

The remaining valve 8 is connected through flexible tube 10, pipe bend 12, circular chamber 39 surrounding the upper neck of dome 31, and rigid pipe 38 extending from chamber 39 horizontally and downwardly, to an upper circular chamber or casing 34 surrounding the lower end of the wall part of dome 31 and separated from the aforementioned chamber 35 by a horizontal separating wall 36. The upper and lower chambers 34-35 are united constructionally into one piece as shown in FIGURES 3 and 4, and rigidly connected to the lower part of dome 31. The hydraulic passage from pipe 13 to central nozzle 42 passes through a wall of the rigid unit and is rigidly suspended therefrom. The upper chamber or casing 34 is formed with a plurality of radial nozzles 37 for generating radial jets for radial digging.

In order to attain optimum efficiency in cutting through muddy earth layers, the following two requirements must be met: First, muddy earth beneath the level of the bottom edge 31' of dome chamber 31 must be cut rapidly and powerfully. Second, there should be provided the minimum necessary constructional parts of the digging unit so far described, below the said level, because otherwise such parts would adversely affect the efficiency of the mud-penetrating operation. For these reasons, circular chambers or casings 34-35 for distributing water to nozzles 42, 40 and 37, are arranged at higher levels than that of said bottom edge, and downwardly projecting nozzles 40 and 42 extend considerably below the level of said bottom edge. By virtue of such arrangement a minimum of disturbing constructional parts are found within the space below bottom edge 31', the penetrating resistance as encountered when passing through voluminous muddy earth layers, if any, is materially reduced. As already described, the connection 14a between pipe 14 and nozzle 7 passes through the wall of dome 31 at a level somewhat higher than the bottom edge 31' and thus contributes considerably in the above meaning.

The above-mentioned jet lifter and cutter assembly is suspended by means of cable 19 from tower frame 20 rigidly mounted on board the floating vessel 1, said cable passing around guide pulleys 21-22 on the tower to a winding drum 23.

Four flexible tubes 10, 11, 15 and 17 leading from rotary pumps 4-5 are guided onto the peripheral surface of a drum 24 having a shaft 25 slidably guided at each of its ends by a pair of vertically extending guide rails 29. Each end of drum shaft 25 is suspended by a cable 26, which extends from the shaft through pulleys 27 and 22 on tower 20 to a winding drum 28. The said winding drums 23 and 28 are suitably mounted on the

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tower frame, though they may be mounted on the deck of the floating vessel, if necessary.

In order to avoid abrupt bending of flexible tubes 10, 11, 15 and 17 in the range between guide drum 24 and rotary pumps 4-6, a pressure member 30 having a semi-cylindrical operating surface is provided and mounted on stand 30', which is in turn fixedly mounted on the deck of the floating hull.

The method of operation is carried out in the following way by using the above-mentioned type apparatus of this invention. First, the drums 23, 28 are operated to let the jet pump 7 go down to the bottom "b" of the water, then pumps 4, 5, 6 are actuated, and when valve 9 is opened and 8 is closed, downward nozzles 40, 42 for shaving and jet pump 7 start operating, suctioning while cutting the layer below the jet pump, and descending quickly by its own weight to reach the gravel layer as shown in FIG. 1. In this case, a hole 43, shown roughly with a dotted line, is cut through. Here, by stopping the descent of the jet pump or reducing the speed thereof, and opening the valve 8, the horizontal nozzle 37 for cutting starts operating, cutting the side wall of the gravel layer, and the jet pump 7 suctions the same together with water. In this case, also, it is preferable to keep the downward nozzles 40, 42 operating, but it is necessary to actuate the horizontal nozzle 37. With the suctioning of gravel, the cavity expands as shown with numerals 44, 45. In this case, as the c-d layer is firm, to such an extent that after excavation the space is occupied, will be in the shape of a flask, and the collection rate of pebbles is satisfactory. Also, as the jet pump suctions sand and pebbles together with water, if a shaving or cutting nozzle is not provided, the seawater flows in a large quantity through the hole 43 into the cavity, with the result that the b-c-d layer collapses, slowing the collection rate of pebbles. According to this invention, however, as the shaving or cutting nozzle is always operating, the water discharged by it serves as the feed water, thereby making it possible to eliminate the defect mentioned above. This is one of the principal characteristics of this invention. Further, it will be ideal if the amount of water discharged by the shaving or cutting nozzle or by both is approximately equal to the amount of water drawn up by the jet pump. The above-mentioned apparatus is designed so that the control of water supply from the downward nozzle for shaving to the horizontal nozzle for cutting is carried out by the valves 8, 9 on the floating operation deck, and, therefore, a total of four flexible pipes are required. However, if the diameter of a flexible pipe is made greater and the digging depth becomes greater, say 50 m. or more, then the operation of a flexible pipe for raising and lowering of the jet pump becomes more complex and a winch capacity therefore has to be increased. Accordingly, it is preferable to reduce the number of flexible pipes whenever possible.

To accomplish this, the use of the modified apparatus of this invention as illustrated in FIG. 6 is effective. This apparatus, without the valve 8 and flexible pipe 10 shown in FIG. 2 and the pipes 12, 39, 38 shown in FIG. 3, employs only a valve 9 and pipe 11. It has a control valve 60 provided at the lower part of the metal pipe 13 shown in FIG. 4 and has lead pipes 61 and 61' fixed to said control valve, the pipe 61 being interconnected to the annular chamber 34 and the pipe 61' to the annular chamber 35 shown in FIG. 4. It is possible to adapt for use as the control valve 60 various structures of the prior art which are capable of being used with the pipes 13, 61 either independently or simultaneously. Such structures are selected preferably which can be controlled from the top of the floating operation deck. Also, it is preferable to attach a device 62 for operatively connecting the valve 60 to the jet pump. The valve may be controlled electrically or hydrodynamically through an electric wire or a pressure fluid pipe 63, respectively, from the top of the floating operation deck. In this apparatus, the winding

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and unwinding operations of the electric wire or of the pipe 63 are less troublesome than operating the water supply pipe leading to the shaving or cutting nozzle. By such means, the apparatus is simplified. The operation of this apparatus is the same as that of the apparatus shown in FIGS. 1 to 5, except for the operation of the valves 8, 9 which is changed to the operation of the valve 61.

In the method stated above, when jet pump 7 descends as it shaves the soil layer b-d, only the downward nozzle for shaving is kept operating, and the apparatus is constructed to make this possible. However, in the apparatus illustrated in FIGS. 1 to 5, it will be noted that when valves 8, 9 are opened to actuate both the downward nozzle for shaving and the horizontal nozzle for cutting, thereby letting the jet pump descend further from the surface of the bottom "b" of the water, a hole, as shown by dotted line 46 in FIG. 1, is cut in the soil layer b-d. The cavity formed following the collection of gravel after the jet pump has reached the gravel layer d-e-f-g is the same as that mentioned above. In this way, even if the horizontal nozzle for cutting is actuated, while the downward nozzle is operating with the jet pump passing through the soil layer, the bore-hole does not become so large. This is thought to be due to the fact that the c-d layer is firm and that the speed of the descent of the jet pump is great due to the effective shaving by the downward nozzle. Also, when the jet pump reaches the d-e-f-g layer, its descent is stopped or the speed of descent thereof is reduced and the horizontal nozzle is actuated to effect collection and, therefore, the cavity gradually becomes large. Accordingly, it is imperative to let the jet pump descend quickly as it passes through the soil layer, and when the jet pump reaches the gravel layer to stop it from going down or to reduce the rate of descent. Bore-holes 43 and 46 (46 being the larger) are both relatively small as compared to the space to be excavated and serve the objects of this invention. In view of the objects of this invention and said experiments, this invention makes it a requirement that the downwardly directed nozzle for shaving be actuated as the jet pump passes through the soil layer to lessen side wall collapse by making the speed of the pump great, and after the pump has reached the gravel layer, the horizontal nozzle for cutting is actuated to speed up collapse of the material and make collection satisfactory. However, as mentioned above, the objects of this invention can be accomplished even by actuating the cutting nozzle further when the pump passes through the soil layer and the shaving nozzle further in the gravel layer.

It is, therefore, possible to further simplify the apparatus of this invention, thereby making the operation easier. FIG. 7 illustrates a further modified form of an apparatus which is not provided with the valve 60, its operating devices 62, 63, branch pipe 61 and partition wall 36 being shown in FIG. 6.

In this modification, the horizontal nozzle for cutting and the downwardly directed nozzle for shaving operate together even while the jet pump is passing through the soil layer, thereby cutting through the hole shown with numeral 46 in FIG. 1, and, therefore, this apparatus is able to carry out the method of this invention.

Further, for reducing the number of flexible pipes, the modified apparatus illustrated in FIG. 8 may be used. In this apparatus, as shown in the drawing, branch pipes 81, 82 are connected respectively to chambers 34, 35 through a pipe 83 and valve 80 from a metal pipe 14 for feeding water to the jet pump. Also, as in the apparatus shown in FIG. 6, there are provided devices 84, 85 for controlling the valve 80 which changes from independent to simultaneous use of the pipes 81, 82. In this apparatus, only two flexible pipes 15, 17 and two pumps 5, 6 are required and, therefore, the structure is further simplified. Furthermore, the invention permits actuation of the downward nozzle for shaving as the jet

pump passes through the soil layer and, in the gravel layer, the downwardly directed nozzle and the horizontal nozzle may be operated together.

FIG. 9 illustrates another modified form of the apparatus which is not provided with the control valve 80, its operating devices 84, 85, partition wall 36 and pipe 83 being shown in FIG. 8. This apparatus is able to carry out the operation similar to that in FIG. 7 by supplying water from the pipe 14 to the shaving nozzles 42, 40 and cutting nozzle 37 through a hole 90, but the number of flexible pipes and pumps required is less than that in FIG. 7 and the structure is simpler.

Next, in the apparatuses illustrated in all figures through FIG. 9, centrifugal pump 5 is provided in series with jet pump 7. This provision of pump 5, as mentioned above, is mainly for the purpose of covering the shortage in the lift of the jet pump 7. Therefore, in cases where the gravel-digging depth is less or where the pressure feed distance of the solids drawn up by the jet pump is short, and in similar situations, the centrifugal pump 5 can be omitted. In this case, the floating operation deck is equipped as shown in FIG. 10, and a combination thereof with the jet pump and shaving and cutting nozzles shown in FIG. 9 simplifies the apparatus of this invention while carrying out the present method.

Various types of jet pumps and shaving and cutting nozzles other than those illustrated can be adapted. For example, when the streamlining of the surface of a jet pumping plant is not taken into consideration, annular chambers 34, 35 can be formed by concentrically fixing a pipe having a section annular to the periphery of the bell-shaped part 31. Also, the terms "downward" as in the downward nozzle and "horizontal" as in the horizontal nozzle do not necessarily always mean exactly vertical or an angle of 90° thereto, and especially, a horizontal jet pump inclined upwardly at an angle of about 30° to the water level may also be used satisfactorily. Further, in the drawings, each nozzle and pump is connected by a long flexible pipe, but it is possible to replace a part of said flexible pipe with a detachable metal pipe.

While the embodiments of this invention have fully been described hereinabove, it will be understood that this invention is not limited to the embodiments shown, but various changes in design thereof may be made without departing from the spirit of this invention.

What I claim is:

1. In an apparatus for removing material from a stratum at a distance below the bed of a body of water, a buoyant operating station, a dredging device associated with said operating station, means for raising and lowering said dredging device, said dredging device comprising a substantially bell-shaped housing having an open bottom, a jet lifter having a nozzle and located in said housing above said open bottom, a downwardly directed jetting nozzle below said open bottom and connected to said housing, annularly arranged downwardly directed cutting nozzles mounted on said housing above and spaced from said jetting nozzle, substantially horizontally outwardly directed slicing nozzles mounted on said housing, above said cutting nozzles, means on said buoyant station for applying operating fluids to the nozzle of said jet lifter, said jetting nozzles, said cutting nozzles and said slicing nozzles.

2. The structure as defined in claim 1 wherein the means for supplying fluid to said jet lifter comprises conduit means passing outside said housing and communicating with the nozzle of said jet lifter and a power driven pump on said buoyant station.

3. The structure as defined in claim 2 wherein the conduit means comprises a pipe line having a branch connected to the nozzle of the jet lifter and further branches connected to said cutting nozzles and to said slicing nozzles, and valve means in said further branch-

ing means to control the passage of fluids to said cutting nozzles and to said slicing nozzles.

4. The structure as defined in claim 3 including a casing surrounding the lower part of said housing and having a partition dividing it into upper and lower chambers, part of said further branching means communicating with said lower chamber, and part of said further branching means communicating with said upper chamber.

5. The structure as defined in claim 1 wherein the means for supplying fluid to said jetting nozzle comprises a conduit means communicating with said nozzle and a power driven pump on said buoyant station.

6. The structure as defined in claim 5 wherein the jetting nozzle is substantially an inverted cone having a digging nozzle opening in its vertex and a plurality of upwardly directed nozzles in its base to assist said jet lifter.

7. The structure as defined in claim 1 wherein the means for supplying fluid to the cutting nozzles comprises an annular chamber surrounding the lower end of said housing and communicating with said cutting nozzles and a connection of said chamber with the means supplying fluid to said jetting nozzle.

8. The structure as defined in claim 1 wherein the means supplying fluid to said slicing nozzles comprises an annular casing surrounding the lower end of said housing and said nozzles being mounted on said annular casing, a pump on said buoyant station and conduit means connecting said pump and said annular casing.

9. The structure as defined in claim 1 wherein the jet lifter comprises an axially positioned constricted tubular member connected with said means for supplying fluid to said jet lifter, a Venturi tube at the upper end of said housing and communicating with said open bottom, an axially positioned longitudinally extending core rod in said constricted tubular member.

10. The structure as defined in claim 9 including a jet booster on said buoyant station.

11. The structure as defined in claim 1 wherein the means for supplying operating fluids to said jet lifter, said jetting nozzles, said cutting nozzles and said slicing nozzles comprises an annular casing surrounding the lower end of said housing and including conduit means connected to said casing and to the nozzle of said jet lifter.

12. The structure as defined in claim 11, wherein the cutting nozzles are annularly arranged on said annular casing and wherein said slicing nozzles are annularly arranged on said annular casing above said cutting nozzles.

13. The structure as defined in claim 1 wherein the means for supplying fluid to the jet lifter, the cutting nozzles and the slicing nozzles includes a casing surrounding the lower part of said housing and said cutting nozzles and said slicing nozzles being mounted on and communicating with said casing, and conduit means passing outside said housing and communicating with said casing and with the nozzle of the jet lifter.

14. The structure as defined in claim 1 including conduit means for conducting fluids to said jetting nozzle, said cutting nozzles and said slicing nozzles comprising, an annular casing surrounding the lower part of said housing and supplying fluid to said cutting nozzles, and said jetting nozzle, an additional annular casing adjacent said first casing, branches in said conduit means connected respectively to said casings and valve means controlling said branches.

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