STATIONARY DREDGING APPARATUS

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References Cited

UNITED STATES PATENTS

2,436,630 2/1948 Clegg................................................. 61/2 X
3,013,395 12/1961 Gaylord............................................. 61/2
3,111,778 11/1963 Fonnesbeck.................................... 37/58

FOREIGN PATENTS OR APPLICATIONS

44,689 1910 Austria.............................................. 61/2

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ABSTRACT

This application discloses apparatus for removing sand and other sedimentary materials from waterways and other submerged locations comprising a generally horizontal perforated pipe extending across the bottom of the waterway and connected to a suction pump above the water level with a high-volume clear water supply conduit entering the perforated conduit near the perforations closest to the pump. The clear water supply may be provided by a suction apparatus or a pressure apparatus, and where the perforations are provided in the bottom of the perforated pipe, the pipe may dig its own channel in the bottom of a waterway.

10 Claims, 6 Drawing Figures
STATIONARY DREDGING APPARATUS

Several proposals have been made in the past for stationary dredging apparatus for automatically removing sand and silt from waterways to prevent the waterways from becoming clogged.

For instance, U.S. Pat. No. 1,042,792 discloses a device for removing sand and silt from reservoirs by means of a water flow into a pipe embedded in the bottom of the reservoir and hence downwardly through a dam which impounds the reservoir. U.S. Pat. No. 2,753,904 discloses a stationary dredging apparatus in which sand is sucked into the end of a pipe from a location where sand is unwanted and delivered to a remote location for disposal where the pipe is provided with an automatic flushing device to clean sand out of the pipe at the time operation of the suction pump is interrupted.

U.S. Pat. No. 3,013,395 discloses a stationary dredging device which employs a series of chambers distributed along the bottom of a waterway which are provided with high-pressure hydraulic jets for moving sand out of the chambers and a water suction removal system for conveying away the sand which is stirred up by the high-pressure jets.

These devices are relatively complex and expensive and have been sufficiently ineffective that they have not led to any widespread use.

It is a principal object of this invention to provide a simple stationary dredge which may be installed at the mouth of a waterway to prevent intrusion of sand and silt into the waterway by continually removing such materials at the entrance to the waterway before they penetrate to any substantial distance into the waterway.

It is a more specific object of this invention to provide such a stationary sand dredge in which the sand removed from the waterway is sucked into a pipe which extends across the bottom of the waterway and is provided with perforations distributed along its length so that migration of sand and silt along the length of the waterway will be blocked at the location of the perforated pipe.

It is another object of this invention to provide all of the operating parts and moving controls for the stationary dredge at a location above water and to provide an apparatus of this type which may be employed at sea level for preventing sedimentary intrusions into rivers, harbors, and similar waterways, and at other locations below dams, mining operations and the like. A variety of sedimentary materials such as sand, gravel, silt, clay and granular ores may be handled in accordance with this invention, and the terms sedimentary material and sand are used herein in their broad sense as including all of the materials mentioned above and similar materials which can be pumped in a liquid medium.

In order to accomplish these objects, it is necessary to mount a suction pump at an elevation above the perforated pipe and to connect the pipe to the pump by an upwardly extending conduit. I have found that such an arrangement of perforated pipe, upwardly extending conduit, and suction pump may be effective for continuous dredging, but this arrangement is subject to complete failure in any situation where fluid flow through the system is interrupted when the system is handling a fluid stream containing a high percentage of solids. Additionally, I have found that such a system cannot be used effectively on an intermittent basis where sand is permitted to accumulate to a substantial depth over the perforated pipe between periods when the suction pump is operated.

In the situations mentioned above, fluid streams containing high percentages of solids are moved up the upwardly inclined pipe until the flow velocity in the pipe decreases to such an extent that solids start to settle in the fluid stream. This condition may be caused in many ways, but regardless of the cause the result produced is a total clogging of the upwardly extending pipe to such an extent that the system must be evacuated to return it to operating condition.

Unfortunately, the same result occurs when the dredging system of perforated pipe, upwardly extending pipe and suction pump is operated intermittently where at the beginning of a cycle of operation the vertically extending pipe is clear but the perforated pipe is covered by sand underneath the water in the waterway. In this situation, the initial operation of the pump draws a heavy slurry of sand and water through the pipe perforations closest to the pump since the velocity of the water stream passing through the perforations is high enough to cause sediment to move. When the slurry moves through the larger diameter pipe, however, the water velocity is reduced, and settling occurs with resultant plugging of the upwardly extending pipe.

I have found that the simple stationary dredging system described above may be made operative, even on an intermittent basis, if a high-volume clear water supply is provided into the perforated and upwardly extending pipes so that any high-solids slurry in the pipe is diluted, and more importantly, so that high-water velocity is maintained in the upwardly extending pipe by reason of a large volume of water flow in the upwardly extending pipe from the clear water supply.

The clear water supply provided in accordance with this invention may be provided by an auxiliary pump which draws clear water from the waterway at a location substantially above the bottom of the waterway with the pump discharging this clear water stream into the perforated pipe or directly into the upwardly extending pipe near its bottom. Preferably, however, the clear water supply is provided by simply connecting to the bottom of the upwardly extending pipe a perforated and short pipe which extends upwardly into clear water and, simply through suction, provides a high volume of clear water in the system.

As indicated above, the clear water supply should provide a large volume of water compared to the capacity of the pump to pump water through the upwardly extending conduit. The clear water supply should be capable of providing at least 20 percent of the pump capacity when all of the holes in the perforated pipe are closed, the preferably the clear water supply provides under these conditions well in excess of 50 percent of the pump capacity. The ideal arrangement of my invention employs a clear water supply providing 100 percent of the pump capacity through a valve which may be closed progressively as the operation of the apparatus progresses. As indicated below, in a preferred structure of the invention, the clear water supply is provided by an open pipe 14 inches in diameter extending into an upwardly extending pipe 20 inches in diameter where the upwardly extending pipe is connected to a pump having a capacity of 15,000 gallons per minute.

Water flow through the clear water supply is most important when a dredging operation is begun with many or all of the holes in the perforated pipe covered with sand since it is in this situation that the greatest danger of pipe plugging is encountered. The clear water supply may be left open even after many of the holes in the perforated pipe are uncovered, and with the clear water supply open, dredging will continue along the length of the perforated pipe. However, the rate of dredging may be increased substantially by closing off the clear water supply after a dredging cycle has continued for a sufficient period of time to uncover enough perforations in the perforated pipe to supply a high volume of clear water in the pipe. For this reason, a shut-off valve is preferably provided in the clear water supply, and it is desirable to provide control means for preventing the pump from being started when the valve in the clear water supply is closed.

The form of the perforations in the perforated pipe may be varied to some extent, and variation in the size of the perforations is desirable depending upon pipe diameter, pump capacity, and the characteristics of the material which is to be dredged by the apparatus. The perforations or lateral openings in the pipe may be provided by a single elongated slot extending along the length of the pipe, but I have found it preferable to employ perforations in the form of circular holes drilled laterally (that is radially) into the pipe with the holes distributed along the length of the pipe. The results of my investigations have indicated that good dredging results are obtained when the adjacent holes are spaced apart by a distance.
equal to 2½ times the pipe diameter. The holes should be made large enough in diameter to pass large objects which may be encountered in the area, and the holes are preferably made large enough so that the total cross-sectional area of the holes is about two and four times the cross-sectional area of the pipe itself. Additionally, it is desirable to construct the apparatus with the end of the perforated pipe remote from the pump completely open so that at the conclusion of each dredging cycle, clear water will be drawn into the pipe through its full diameter from the remote end flushing out of the pipe any large debris which has entered the pipe through the perforations.

Since the stationary apparatus of this invention operates effectively even when it is operated periodically completely buried in the sand, it is possible to provide a variation of this invention in which a perforated pipe is employed with perforations in its bottom surface so that the pipe will dredge sand from underneath itself and dig its own way into the sand. In this regard, it should be noted that where this invention is employed to protect the waterway from the intrusion of sand and silt, it is desirable that the perforated pipe be located adjacent to the bottom of the waterway but preferably in a trough formed in the bottom of the waterway. When the invention is employed in this way, the dredging apparatus may be operated periodically to dredge out the trough over the perforated pipe and then permitted to stand idle while intruding sand covers up the trough previously formed. Where the perforated pipe is located a fair distance below the bottom of the waterway, each dredging operation is very effective in removing sand over a fairly wide area which is wider than the pipe and longer than the pipe by distances determined by the angle of repose of the particular sand in water and distance of the pipe underneath the normal bottom of the waterway.

Other features and advantages of the invention will become apparent from the following description of certain illustrative embodiments of this invention, it being understood that the embodiments illustrated in the attached drawings and described in detail merely illustrate certain ways in which the invention may be used without any attempt to show all of the various structures which may be made within the spirit of the invention.

In the attached drawings:

FIG. 1 is a perspective view of a waterway which is protected by a stationary dredging apparatus of this invention;

FIG. 2 is a vertical sectional view taken along the plane indicated at 2—2 in FIG. 1;

FIG. 3 is a vertical sectional view taken along the plane 3—3 in FIG. 2;

FIG. 4 is a view similar to FIG. 2 showing an alternative form of the invention;

FIG. 5 is a vertical sectional view taken along the plane indicated at 5—5 in FIG. 4, and;

FIG. 6 is another vertical sectional view similar to FIGS. 2 and 4 showing another alternative form of the invention.

Referring now in detail to the drawings and particularly to FIGS. 1—3, a waterway 10 extends through the beach 12 to an ocean 14 providing a channel for cooling water to a hydroelectric plant. An onshore current indicated by arrow 16 provides a hazard for beach erosion which is prevented by a breakwater 18 protecting the mouth of the waterway 10. While the breakwater protects the mouth of the waterway from erosion, it provides a current indicated by arrow 20 which tends to deposit sand in the quiet water behind the breakwater 18, necessitating periodic dredging of the mouth of the waterway to insure adequate water flow through the waterway during low tide.

The stationary dredging apparatus of my invention is installed to remove sand deposits at the mouth of waterway 10 by periodically drawing sand and water into a perforated pipe 22 which is connected to an upwardly extending pipe 24 and hence through a horizontal pipe section 26 to the suction side of a dredging pump 28, the discharge of which extends in the direction of arrow 30 through an elongated circuit not shown in a remote location. As best seen in FIG. 2, a plurality of lateral openings 34 are provided in the upper side of the pipe 22.

A clear water supply is provided to the pipe 22 by means of a vertical conduit 36 having a valve 38 on its upper end and an intake conduit 40 which is located above the normal bottom 42 of the waterway but below the low-water level 44 of the water in the waterway at low tide.

In a preferred form of my invention, the apparatus illustrated in FIGS. 1—3 is constructed with a suction dredging pump 28 having a capacity to pump 15,000 gallons per minute at a rated input suction of 24 inches of mercury and an output pressure of 177 feet of water. The pump is driven by an electric motor 32 having a rated horsepower of 1500. The conduits 22, 24 and 26 are 20-inch diameter with the conduits 36 and 40 having a 14-inch diameter while the perforations 34 are 6-inch diameter circular holes cut into the pipe 22 on 50-inch centers. The valve 38 is illustrated for convenience as a manual valve, but is preferably a pneumatically operated valve located above the water level 44 and controlled from the station of pump 28.

When the apparatus of FIGS. 1—3 is initially installed, a dredge is employed to open a channel to the illustrated depth of the conduit 22, and the conduit 22 is then laid in place. Thereafter, the pump 28 may be shut down for sufficient periods of time to permit intruding sand to cover the pipe 22 to a level 42 in FIG. 2. The intruding sand may then be removed by starting operation of the pump 28 while the valve 38 is open. Initial suction applied to the conduit 22 will draw clear water and sand into the conduit 22 through the hole 34 closest to the pump 28 and will simultaneously draw a large volume of clear water through conduits 40 and 36. The entering clear water prevents sand from settling in this conduit and plugging the apparatus, and continued operation of the pump 28 will cause additional sand to be removed around the pipe 22 progressively uncovering additional perforations 34. After about 10 of the perforations 34 are uncovered, the valve 28 may be closed to accelerate further dredging along the length of pipe 22. Dredging will continue until the sand level adjacent to pipe 22 has been lowered to the phantom line position illustrated at 46 in FIGS. 2 and 3 at which time a large volume of clear water will be drawn through the open remote end of the pipe 22 as indicated at 48 to flush out of the pipe any large objects such as rocks, beer cans, and kelp which may have entered the perforated pipe through the perforations 34. When the sand adjacent to the pipe 22 has been dredged as described above, the pump 28 may be shut down again until additional sand accumulates for removal.

In the alternative form of the apparatus illustrated in FIGS. 4 and 5, a similar perforated pipe 22 is employed with an upwardly extending pipe 24, and clear water supplies 36, 38 and 40. Additionally, a second pipe 50 is welded to the underside of pipe 22 and connected to an upwardly extending pipe 52 and horizontal pipe 54 which is adapted to be connected to the pump 28. The pipe 52 is provided with a series of perforations 56 in its underside, and a clear water supply pipe 58, valve 60 and conduit 62 are connected to the pipe 50 similar to the clear water supply for pipe 22. The apparatus of FIGS. 4 and 5 may be mounted in place in a channel in the bottom of the waterway without employing an auxiliary dredge to dig the channel. Thus, when pump 28 is employed for pumping water and sand from conduit 54, the lower perforated pipe 50 dredges sand out from underneath itself thereby digging its own channel into the bottom of the waterway.

With reference to FIG. 6, the apparatus illustrated therein is similar to the apparatus of FIGS. 1—3 in that it employs the same perforated pipe 22, upwardly extending conduit 24, clear water supply pipe 36, and clear water supply to pipe 36 is provided by a pump 64 which has its suction side connected through conduit 66 to the water in waterway 10 above the bottom of the waterway and below the water level therein so that when pump 64 is operated, clear water is forced into the pipe 24 to maintain adequate water...
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volume and velocity therein to prevent sand from settling. As indicated above, the form of my invention illustrated in FIGS. 1-3 is much preferred over the form illustrated in FIG. 6 both because of the simplicity of the apparatus of FIG. 1 and also because the apparatus of FIG. 1 does not involve the problem encountered with the apparatus of FIG. 6 of balancing the hydraulic operating conditions of pumps 64 and 28 to prevent insufficient flow from pump 64. Insufficient flow from pump 64 may cause sand to settle in the pipe 24 while excessive flow from pump 64 may reduce the flow rate in the perforated pipe 22 preventing effective dredging action therein and impacting sand already present in the pipe.

Automatic controls may be employed for the valve 38 in the clear water supply, controlled by pump vacuum for instance, to maintain a balance between high-dredging rate and protection against pipe plugging.

While certain features and advantages of the invention have been illustrated and described in detail herein, it is obvious that many modifications thereof may be made without departing from the spirit and scope of the invention.

I claim:

1. Apparatus for removing sediment submerged in water which comprises:
   A. a stationary dredging conduit submerged under a body of water near the bottom thereof with said conduit having lateral passageway means opening into said conduit with said passageway means distributed along the length of said conduit;
   B. a pump having an intake opening;
   C. a connecting conduit connected to said dredging conduit and extending therefrom to the intake opening of said pump; and
   D. water supply means for introducing clear water into said conduits at a location between said lateral passageway means and said pump below the water level in said body of water adjacent that part of said lateral passageway means in said dredging conduit which is closest to said connecting conduit with said water supply means having a capacity for introducing water at said location which is greater than 20 percent of the capacity of said pump to pump water through said conduits.

2. The apparatus of claim 1 in which said water supply means comprises means for introducing clear water at said location in said conduits in an amount of at least 50 percent of the capacity of said pump.

3. The apparatus of claim 1 in which said water supply means comprises means including a valve for introducing clear water at said location in said conduits in an amount which is at least 100 percent of the capacity of said pump when said valve is open.

4. The apparatus of claim 1 in which said water supply means comprises a suction pipe extending from said conduits to a location in said body of water above the bottom thereof and below the water level thereof.

5. The apparatus of claim 1 in which said water supply means comprises a pipe extending from said conduits at said location, a pump having a discharge opening connected to said pipe and an intake opening communicating with said body of water above the bottom thereof and below the water level thereof.

6. The apparatus of claim 1 characterized further in that said lateral passageway means are located above the bottom of said dredging conduit for removing from said body of water sand which approaches said dredging conduit.

7. The apparatus of claim 1 characterized further in that said lateral passageway means are located in the bottom of said dredging conduit for removing sand from underneath said dredging conduit and causing said dredging conduit to sink into the bottom of said body of water responsive to operation of said pump.

8. Apparatus for preventing sand intrusion into a waterway which comprises:
   A. a dredging conduit in said waterway adjacent to the bottom thereof with said conduit having lateral passageway means opening into said conduit adjacent to the top thereof with said passageway means distributed along the length of said conduit;
   B. an upwardly extending conduit connected to said dredging conduit and extending upwardly therefrom;
   C. a pump having an intake opening connected to said upwardly extending conduit; and
   D. a suction conduit extending from a first location below the water level in said waterway substantially above the bottom of said waterway to said conduits at a second location adjacent to that part of said lateral passageway means which is closest to said upwardly extending conduit.

9. The apparatus of claim 8 characterized further in that said suction conduit extends from said first location to a position above said water level and hence to said second position, and a valve is mounted in said suction conduit above the water level.

10. The apparatus of claim 8 characterized further in that said suction conduit has a diameter at least 50 percent as large as the diameter of said upwardly extending conduit.

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