Sept. 1, 1964 E. VON BOLHAR 3,146,537

FLOATING DREDGE DESIGN

Filed May 7, 1962 5 Sheets-Sheet 1

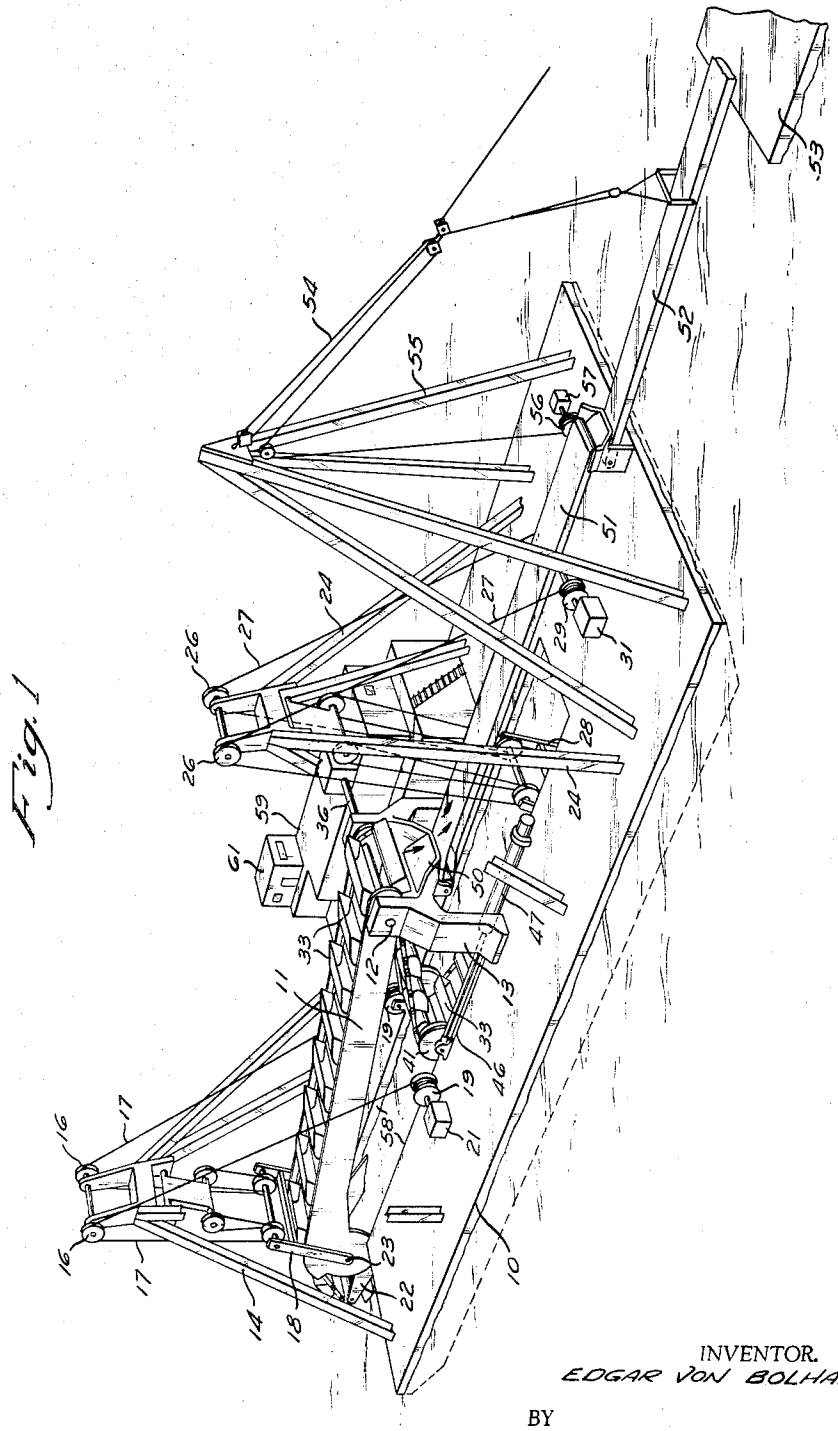

Fig. 1

INVENTOR.
EDGAR VON BOLHAR

BY
RICHEY, McNENNY & FARRINGTON
W. F. McNenny
ATTORNEYS

Sept. 1, 1964 E. VON BOLHAR 3,146,537

FLOATING DREDGE DESIGN

Filed May 7, 1962 5 Sheets-Sheet 2

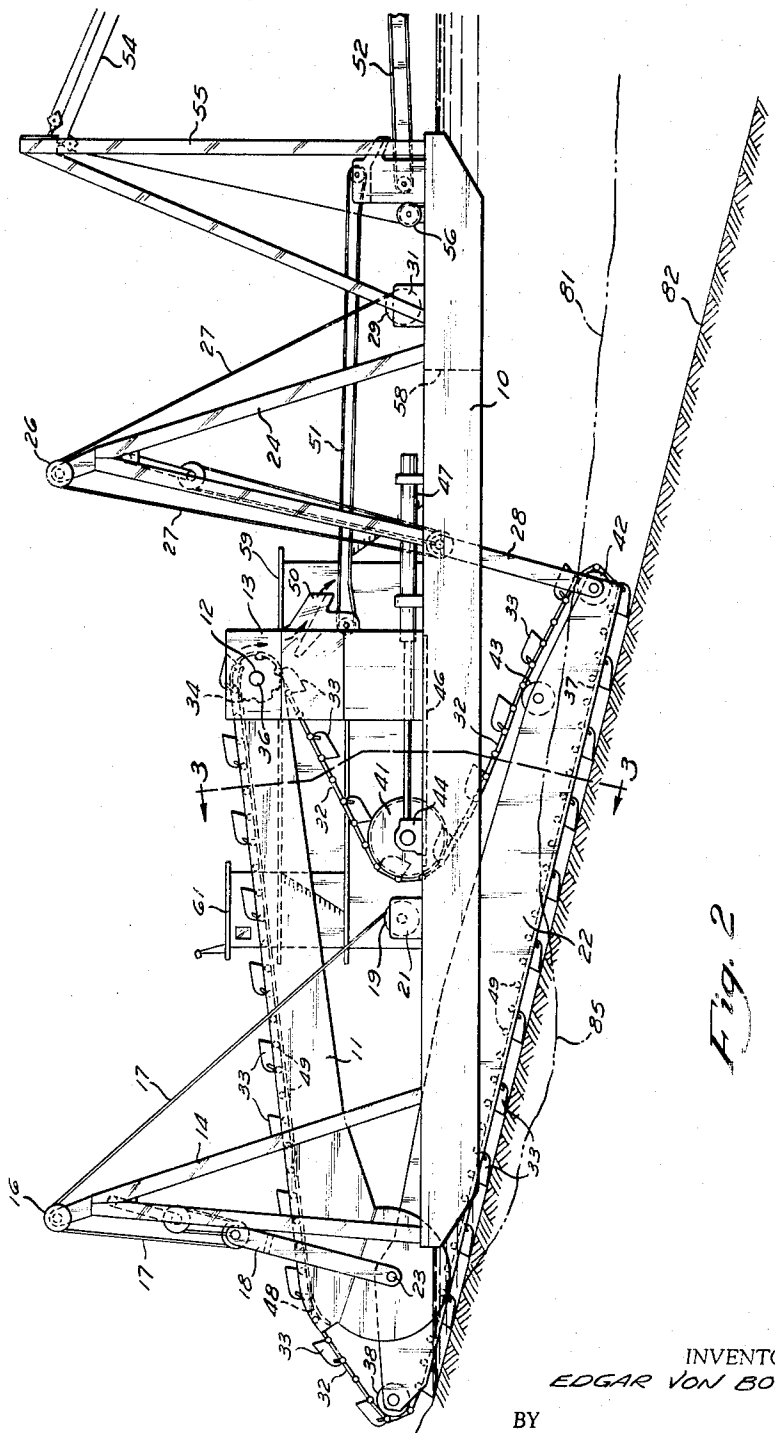

Fig. 2

INVENTOR.
EDGAR VON BOLHAR

BY
RICHEY, McNENNY & FARRINGTON
R. F. McNenny
ATTORNEYS

Sept. 1, 1964 E. VON BOLHAR 3,146,537

FLOATING DREDGE DESIGN

Filed May 7, 1962 5 Sheets-Sheet 3

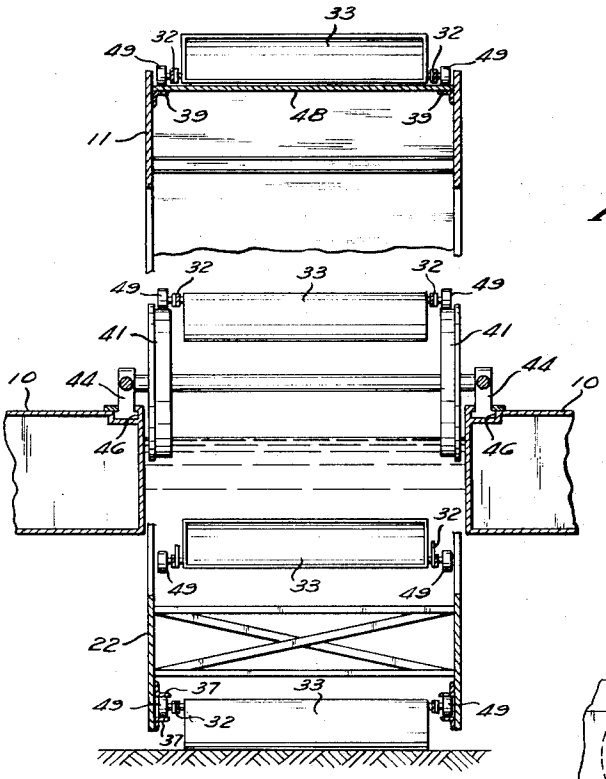

Fig. 3

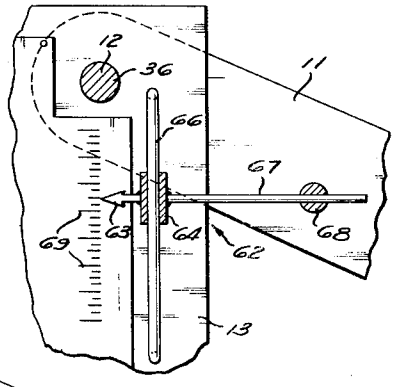

Fig. 5a

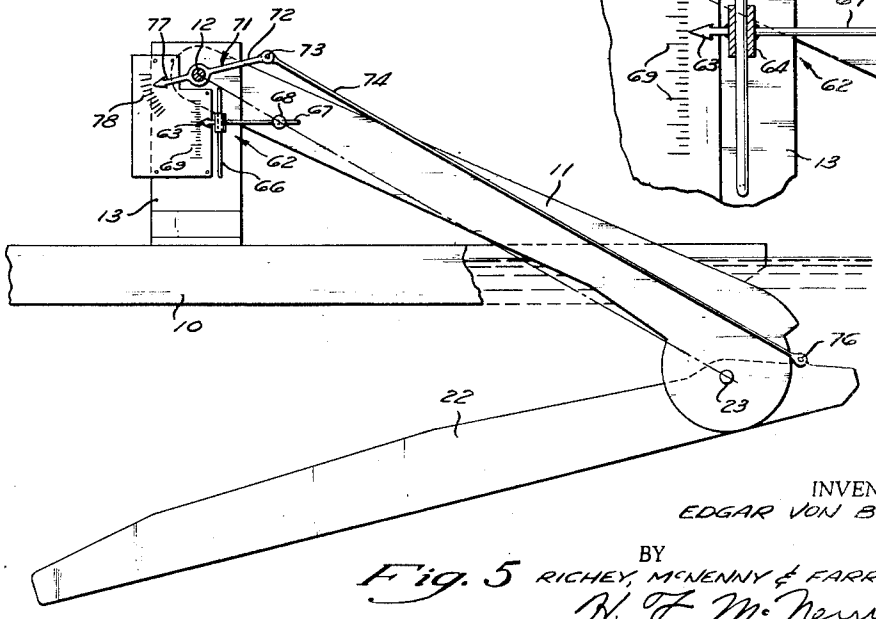

Fig. 5

INVENTOR.
EDGAR VON BOLHAR

BY
RICHEY, McNENNY & FARRINGTON
H. F. McNenny
ATTORNEYS

Sept. 1, 1964 E. VON BOLHAR 3,146,537

FLOATING DREDGE DESIGN

Filed May 7, 1962 5 Sheets-Sheet 4

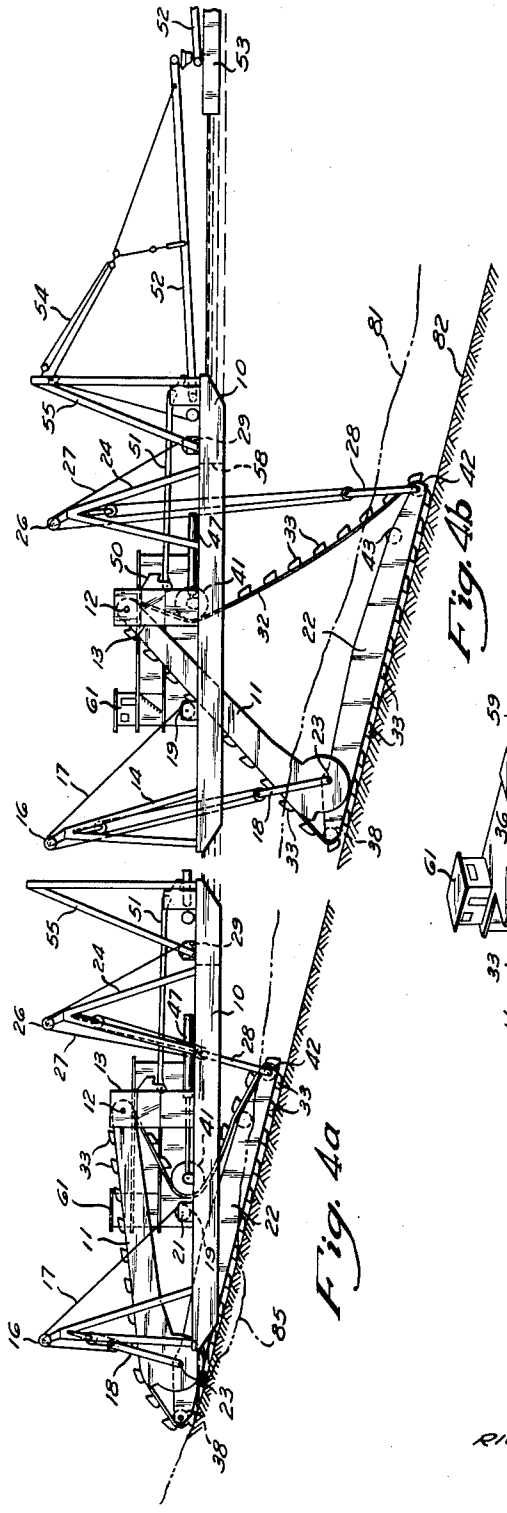

Fig. 4a

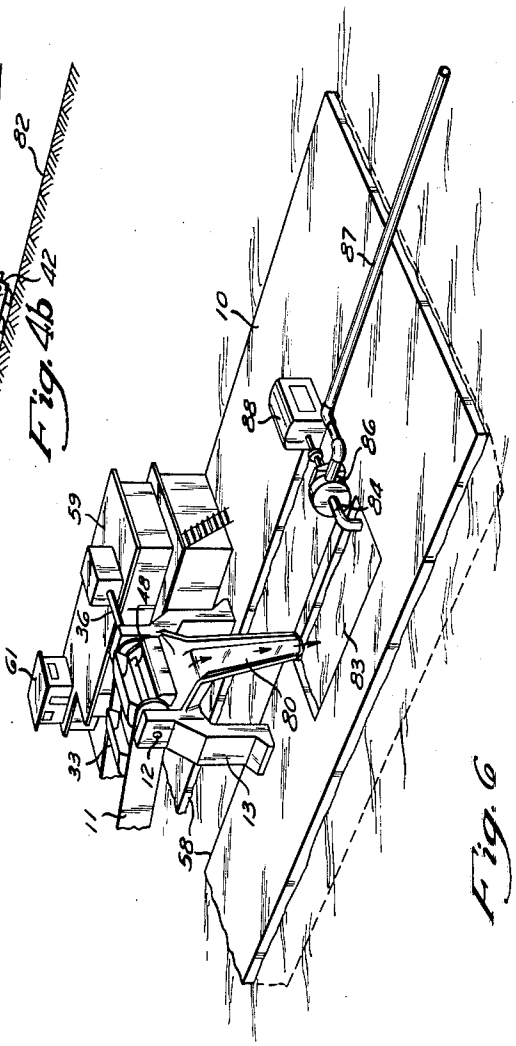

Fig. 6

INVENTOR.
EDGAR VON BOLHAR

BY
RICHEY, McNENNY & FARRINGTON
N. F. McNenny
ATTORNEYS

Sept. 1, 1964 E. VON BOLHAR 3,146,537

FLOATING DREDGE DESIGN

Filed May 7, 1962 5 Sheets-Sheet 5

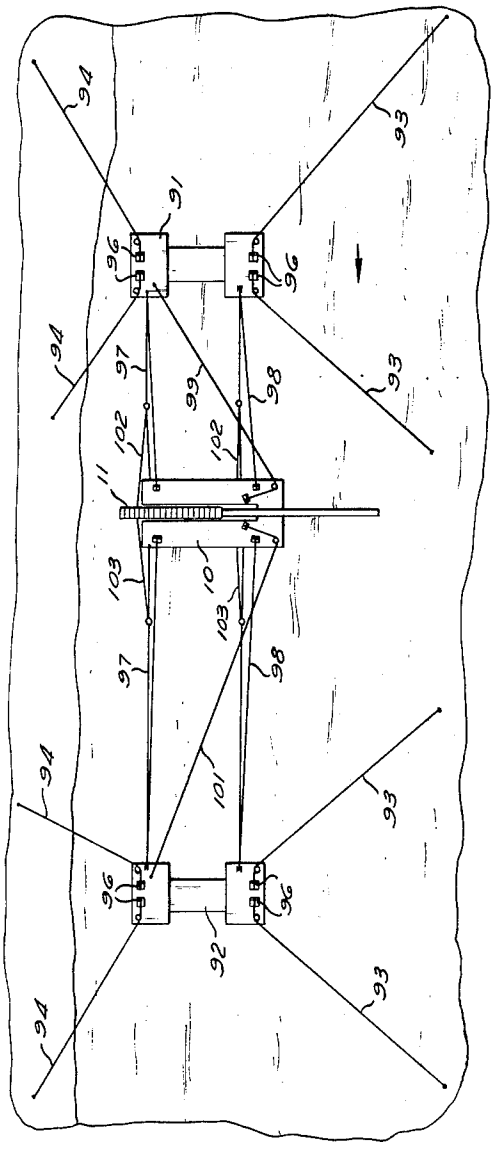

Fig. 7a

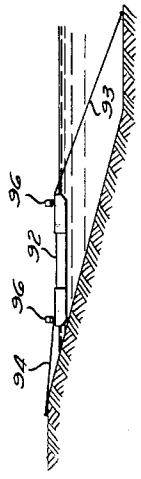

Fig. 7b

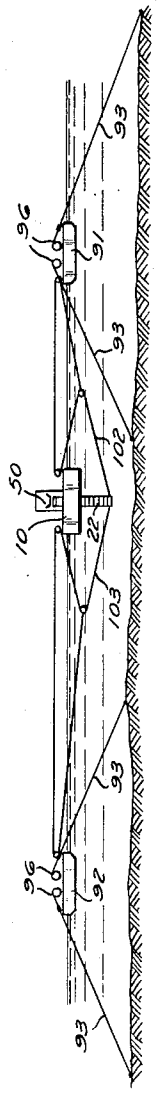

Fig. 7c

INVENTOR.
EDGAR VON BOLHAR

BY
RICHEY, McNENNY & FARRINGTON
W. F. McNenny
ATTORNEYS

United States Patent Office 3,146,537 Patented Sept. 1, 1964

3,146,537

FLOATING DREDGE DESIGN

Edgar von Bolhar, Severna Park, Md., assignor to Ellicott Machine Corporation, Baltimore, Md., a corporation of Maryland

Filed May 7, 1962, Ser. No. 192,860
5 Claims. (Cl. 37—69)

This invention relates generally to dredges and more particularly to a novel and improved, high-capacity dredge for excavating and grading the bottoms of rivers, lakes, harbors and the like.

The commercial success of the dredge hinges to a great extent upon two prime factors; the cost of dredging a given volume of material, and the accuracy with which the dredge maintains the depth of dredging. The first factor, the cost of dredging, of course, determines the dredge owners expense and therefore, should be as low as possible. The second factor, the accuracy of dredging, however, is also critical since it is customary to price a particular dredging operation on the basis of the amount of material which must be excavated or dredged to obtain a designated depth. If the operator dredges to a depth beyond that required, he receives little or no compensation for the excessive dredging.

The maintenance of depth accuracy has in the past depended to a great extent upon the skill of the operator in judging an operation which he cannot observe under muddy waters present during dredging operations.

A dredge incorporating this invention operates economically since the dredging is continuous and the material dredged is carried to the desired location without double handling or the use of separate handling equipment. An endless bucket chain performs the dredging and by virtue of its continuous operation, the dredging capacity is high. Such a bucket chain operates with substantially uniform power requirements so that the power equipment for driving the chain is substantially uniformly loaded. This promotes operating economy. Continuously operating conveyor means also are provided to transport the material dredged by the bucket chain to the desired location for deposit. Here again, continuous operation of conveying also lends to operating economy since the operating power load is substantially uniform.

The accuracy of dredging depth control is achieved by providing a submerged ladder with positive guide tracks to accurately position the buckets during the dredging operation in combination with support means for the submerged ladder which enables the operator to accurately position the ladder.

Since the dredge incorporating this invention economically operates to perform the dredging operation and since the dredge is arranged to permit the operator to accurately control the depth and grade of dredging, a commercially superior dredge results.

It is an important object of the invention to provide a novel and improved dredge which efficiently operates to accurately excavate and grade sub-aqueous material.

It is another important object of this invention to provide a novel and improved dredge operable to continuously excavate, grade and transport the excavated material at locations remote from the dredge to eliminate double handling of the excavated material.

It is still another object of this invention to provide a novel and improved dredge operable to economically excavate large amounts of sub-aqueous material while maintaining accuracy of depth and grade.

It is still another object of this invention to provide a dredge having novel and improved means to enable the operator to accurately determine the depth and grade of a sub-aqueous excavating operation.

It is still another object of this invention to provide a novel and improved integrated dredge combining a bucket chain to excavate and grade sub-aqueous material with a system of transportation for transporting and depositing the excavated material, thereby minimize the requirement of separate handling equipment.

Other objects and advantages will appear from the following description and drawings, wherein—

FIGURE 1 is a perspective view of a dredge incorporating this invention;

FIGURE 2 is a side elevation illustrating the general structure of the bucket chain and support mechanism therefor;

FIGURE 3 is a section taken along 3—3 of FIGURE 2;

FIGURE 4*a* and FIGURE 4*b* are comparative views, in side elevation, illustrating the operation of the dredge in grading and excavating a continuous slope;

FIGURE 5 is a schematic view of the indicators for informing the operator of the position and depth of the lower ladder;

FIGURE 5*a* is an enlarged fragmentary view of the depth indicator;

FIGURE 6 is a fragmentary perspective view of a second form of this invention, wherein a hydraulic pump and pipe line is used to transport and discharge the excavated material;

FIGURE 7*a* is a plan view of one preferred arrangement for controlling the position and movement of the dredge during a dredging operation;

FIGURE 7*b* is an end view illustrating the anchor line arrangement for the anchor barges; and

FIGURE 7*c* is a side elevation illustrating the cable arrangement for controlling the position of the dredge.

The machinery of the dredge is mounted on a barge type hull **10**. An upper or articulated ladder **11** is pivoted at **12** on a rigid support **13** mounted on the deck of the hull **10**. A forward winch mast **14** is mounted at the forward end of the hull **10** and is provided with cable sheaves **16** over which forward winch cables **17** extend. The forward winch cables **17** connect to a yoke **18** pivotally connected at **23** to the forward end of the upper ladder **11** for raising and lowering of the ladder causing it to pivot around its pivot **12**. Suitable forward winch drums **19** and forward winch drives **21** operate the cables **17**.

A lower ladder **22** is pivoted at **23** to the upper ladder **11** and extends back along the dredge as best illustrated in FIGURE 2. A second winch mast **24** is mounted on the hull **10** above the rearward end of the lower ladder **22** and is again provided with cable sheaves **26** and winch cables **27** which connect to a yoke **28** mounted at the rearward end of the lower ladder **22**. Here again, suitable cable drum **29** and power drive **31** are connected to the cables **27** and operated to raise and lower the rearward end of the lower ladder **22**. Thus, the lower ladder **22** can be raised or lowered by the proper operation of the two winch drives **21** and **31**. The forward winch determines the depth of the forward end of the ladder **22** and the rearward winch determines the depth of the rearward end of the lower ladder. The upper ladder **11** serves as a rigid articulated support which, in cooperation with the two winches, accurately positions the lower ladder.

A pair of continuous parallel chains **32** carry buckets **33** around the two ladders **11** and **22**. The chains **32** are provided with rollers **49** which move along tracks **37** (illustrated in FIGURE 3) on the lower ladder **22** around the idler sprocket **38** at the forward end of the lower ladder and up along tracks **39** on the upper ladder **11**, to drive sprockets **34** illustrated in FIGURE 2. From the sprockets **34** the chains extend around tension-

ing idlers 41 to idler sprockets 42 pivoted at the rearward end of the lower ladder 22. Additional idlers 43 are mounted on the upper side of the lower ladder 22 to engage the chains 32 when the lower ladder is raised near the surface.

The drive sprockets are mounted on and driven by a drive shaft 36 which is powered by a suitable engine drive (not shown) in the machinery house 59. In the illustrated embodiment the drive shaft also serves as the pivot shaft of the pivot 12.

Buckets 33 are mounted between the chains and are carried thereby around the two ladders 11 and 22. These buckets 33 are constructed so that they excavate the subaqueous material as they move along the lower ladder 22 and carry the excavated material up along the upper ladder. They are inverted as they pass by the drive sprockets 34 and empty onto a chute 50.

The tensioning idlers 41 are supported on bearing blocks 44 which slide along tracks 46 on the deck of the hull 10 and are pressed forward by fluid pressure operated actuator 47 to maintain the proper tension on the chains 32. As the two ladders 11 and 22 are lowered, it is necessary for the tension idlers 41 to move back along the hull 10 against the force of the actuators 47. Conversely, when the ladders are raised, it is necessary for the idlers 41 to move forward under the influence of the actuators 47 to maintain the proper tension in the chains 32. The actuators 47 are preferably of the piston and cylinder type maintained at a fluid pressure which will produce a forward force on the idlers 41 of the required magnitude to maintain the proper tension in the chains 32.

Referring again to FIGURE 3, rollers 49 are mounted on the chains 32 at equally spaced points along the chains to support the chains in the various tracks and to engage the drive sprockets 34 for driving the chains on the ladders. These rollers and tracks operate to accurately position the chains 32 and in turn, the buckets 33 as they move. The upper ladder 11 is provided with a plate 48 immediately adjacent to the buckets 33 along which the buckets move to prevent the excavated material from dropping down out of the buckets until they reach the area of the sprockets 34. The chute 50 on the support 13 receives the excavated material and carries it to a belt conveyor 51, driven to transport the excavated material to the stern of the hull 10. From there, the conveyor drops the material onto a series of conveyors, the first of which is illustrated at 52. The conveyors carry the excavated material to the desired location for deposit. Generally, the conveyors 52 are of the shaker-type which are supported on floats 53 in the usual manner. A stern mast 55 is provided to support the conveyor winch cables 54. Here again, a power driven winch drum 56 having a drive 57 is used to power the conveyor winch.

The hull 10 is generally U-shape, having a central longitudinally extending well 58 through which the ladders and chains extend. The lower ladder 22 may be raised to a position within the well 58 wherein the buckets 33 extending along the lower side of the ladder are above the bottom of the hull so that the dredge can be moved through relatively shallow water.

The machinery house 59 is provided on one side of the hull 10 to house the various power drives and to provide the necessary crew facilities. The controls for all of the winches and various other power accessories are located in a control house 61 above the machinery house 59.

In order to provide the operator with an exact indication of the position of the lower ladder 22, an indicator system illustrated schematically in FIGURES 5 and 5*a* is used. Various elements have been removed for simplification and the relative sizes of the indicator elements are exaggerated.

In order to determine the depth of the forward end of the ladder 22, a depth indicator 62 is provided. The depth indicator 62 includes a vertically movable arm 63 restrained to move vertically by a collar 64 slidable on a rod 66 which is in turn mounted on the support 13. A second arm 67 extends from the rearward side of the collar 64 through a sleeve 68 pivoted on the upper ladder 11. As the ladder 11 rotates about its pivot 12, the pivot 68 moves up and down carrying with it the arm 67. During such movement the sleeve slides horizontally along the arm 67. Therefore, the vertical position of the arm 63 is determined by the vertical position of the pivoted sleeve 68, which is in turn determined solely by the position of the upper ladder 11. Since the upper ladder 11 is rigid, the position of the arm 63 is directly related to the vertical position of the pivot 23 at the lower end of the ladder 11. Since the lower ladder is connected at the pivot 23, the height of the buckets moving along the lower ladder 22 immediately below the pivot 23 is therefore directly related to the vertical position of the arms 63 and 67. A scale 69 is calibrated in depth of the buckets 33 immediately below the pivot 23 and permits the operator to see at a glance their exact depth.

In order to determine the angle of the lower ladder 22 the slope indicator informs the operator of the exact slope of the ladder and with the depth information of the indicator 62, informs the operator of the exact position and depth of the lower ladder 22. To provide the slope indication, a parallelogram structure is used. A slope indicator arm 71 is pivoted on the support 13 for rotation about the axis of the pivot 12 and is formed with an arm 72 pivoted at 73 to a rod 74. The lower end of the rod 74 is pivoted at 76 to the lower ladder 22. The rod 74 has a length equal to the spacing in between the pivots 12 and 23 and the distance between the pivots 23 and 76 is equal to the distance between the pivots 12 and 73. Therefore, a parallelogram is provided which includes the upper ladder 11, the indicator arm 72, the portion of the lower ladder between the pivot 23 and 76, and the rod 74. The indicator 71 is, therefore, always positioned with its arm 72 parallel to the line between the two pivots 23 and 76. The indicator 71 is provided with a pointer 77 which in cooperation with a scale 78 on the support 13 indicates the angle of the lower ladder 22. It should be recognized that the depth and angle indicators are schematically illustrated and that other forms of indicating mechanisms may be provided. In addition, remote read-out equipment can be located in the control house 61 convenient to the operator of the dredge.

Since the two indicators provide a continuous indication of the depth and angle of the lower ladder, the operator is able to control the two winch drives 21 and 31 to accurately position the lower ladder 22 and in turn, accurately excavate to the desired depth and grade even though the operation is performed under muddy waters, stirred up by the excavation process.

Reference should now be made to FIGURES 4*a* and 4*b* which illustrate the operation of the dredge in establishing a grade for river bank revetments and the like. The river bottom before excavation and dredging is indicated by the broken line 81 and after dredging by the grade line 82. In FIGURE 4*b*, the dredge is shown as it moves toward shore, dredging the river bottom to the desired grade. The buckets 33 are carried by the chains 32 along the lower ladder 22 to continuously remove material as the dredge is moved forward. The material in the buckets 33 is carried up along the upper ladder 11 and is deposited on the chute 50 and carried to the desired location of the deposit by the conveyors 51 and 52.

As the dredge moves forward, the forward winch drum 19 is operated to raise the upper ladder 11 to adjust the depth of the forward portion of the lower ladder 22 and the rearward winch drum 29 is operated to maintaian the required angle of the lower ladder 22. Therefore, the ladder 22 is accurately positioned and the grade is accurately determined. If there are any holes in the river bottom as indicated at 85 which extend below the

grade level required, the action of the buckets 33 will cause the holes to be filled and produce a smooth grade.

As the dredge continues to excavate the bottom, it is moved toward shore to the position illustrated in FIGURE 4*a*. During the forward movement of the dredge, the winch drums 19 and 29 are operated to maintain the required position of the lower ladder 22. A comparison of FIGURES 4*a* and 4*b* will illustrate that as the dredge is moved toward shore, the forward end of the lower ladder 22 is raised by raising the upper ladder 11 to a more nearly horizontal position and the angle of the lower ladder 22 is maintained by properly operating the winch connected to the rearward end of the ladder. The actuators 47 extend as the lower ladder is raised to maintain the proper tension in the chains 32.

The dirt removed from the bottom is carried continuously by the endless chain of buckets 33 to the conveyors 51 and 52 to a location where it is deposited. In many cases, the material is dropped in the center of the stream where the current carries it away. In other cases, the conveyors are arranged to carry the material to the shore to build up the bank.

In FIGURE 6, a second embodiment of the invention is illustrated wherein the transportation of the material excavated is performed by a hydraulic pump and pipe line. In this embodiment, the chute 80 carries the material laterally to a sump 83 formed in the hull 10 and provided with openings which allow water to enter the sump 83 and mix with the material. The mixture of water and excavated material is then pumped through an intake pipe 84 to a hydraulic pump 85 and discharged therefrom through a pipe line 87. A suitable engine 88 is used to drive the pump. This equipment method of hydraulic transportation of the material has the advantage when the material is to be carried a considerable distance before being deposited and is normally used when the material is to be deposited either on the river bank or in locations substantial distances from the dredge. The operation of the continuous bucket chain however, is identical in both embodiments.

Reference should now be made to FIGURES 7*a* through 7*c* which illustrate one apparatus for accurately controlling the position and movement of the dredge itself. The dredge hull 10 is suspended or supported between two anchor barges 91 and 92. The anchor barges 91 and 92 are positioned with the barge 91 upstream from the dredge and the barge 92 downstream therefrom. Anchor lines 93 extend to offshore anchors and coperate with onshore anchor lines 94 to accurately locate the barges in position. Power winches 96 on the barges control the anchor lines 93 and 94.

The dredge is connected by bow lines 97 and parallel stern lines 98 to the two barges 91 and 92. When the upstream lines 97 and 98 are taken in, while letting out the downstream lines, the dredge is moved upstream toward the barge 91. Conversely, when the downstream lines are taken in while letting out the upstream lines, the dredge moves downstream toward the barge 92. A pair of lines 99 and 101 are used to move the dredge toward shore during the dredging operations. The line 99 connects the stern of the hull 10 to the forward or shore end of the barge 91 and similarly the line 101 connects the stern of the hull 10 to the forward end of the barge 92. As the two lines 99 and 101 are taken in, the dredge hull 10 is moved forward toward the shore against the reaction thrust produced by the buckets.

The lower end of the ladder is laterally supported by lines 102 and 103 illustrated in FIGURE 7*c*. Since the lower ladder 22 and the upper ladder 11 are subjected to the flow forces of the stream, the lower support of the lines 102 and 103 often are required.

When a dredge incorporating this invention is used in the dredging of harbors or channels, the rigging for moving the dredge and locating it can be changed to meet the needs of the particular operation.

Because the dredge incorporating this invention accurately maintains the desired depth and grade angle of dredging and operates to continuously remove material from the bottom, it is economical to operate, provides high dredging capacity. Because the depth and grade can be accurately maintained, time and effort is not wasted in overdredging, yet the required minimums are achieved. The action of the dredge in filling holes which may be encountered also improves the overall results achieved since the material used to fill the holes need not be carried away from the site. Since the grade resulting is smooth, the cement mattress which is laid during the construction of the revetment lays smoothly along the bottom of the river.

Although preferred embodiments of this invention are illustrated, it is to be understood that various modifications and rearrangements of parts may be resorted to without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. A dredge comprising a hull, an upper ladder, a first pivot connecting one end of said upper ladder to said hull, a lower ladder, a second pivot connecting one end of said lower ladder to the opposite end of said upper ladder, hoist means operable to control the depth and angle of said lower ladder relative to said hull, a first indicator, a connection between said upper ladder at a point spaced from said first pivot and said first indicator moving said first indicator vertically relative to said hull as said upper ladder pivots relative thereto, a second indicator on said hull, operating means connecting said lower ladder and said second indicator maintaining a fixed relationship between the position of said second indicator relative to said hull and the angle of said lower ladder, a power driven endless bucket chain, and means guiding said chain along said lower ladder for dredging and up along said upper ladder to said hull to carry dredged material to said hull.

2. A dredge comprising a hull, an upper ladder, a first pivot connecting one end of said upper ladder to said hull, a lower ladder, a second pivot connecting one end of said lower ladder to the opposite end of said upper ladder, hoist means operable to control the depth and angle of said lower ladder relative to said hull, first indicator means, a connection between said upper ladder at a point spaced from said first pivot and said first indicator means moving said first indicator means relative to said hull as said upper ladder pivots relative thereto, second indicator means pivoted on said hull, operating means connected between said lower ladder and said second indicator means rotating the latter in fixed relationship to the angle of said lower ladder relative to said hull, a power driven endless bucket chain, means guiding said chain along said lower ladder for dredging and up along said upper ladder to said hull to carry dredged material to said hull, and conveyor means operable to receive said dredged material from said bucket chains and carry it to a location for deposit.

3. A dredge comprising a hull, an upper ladder, a first pivot connecting one end of said upper ladder to said hull, a lower ladder, a second pivot connecting one end of said lower ladder to the opposite end of said upper ladder, hoist means operable to control the depth and angle of said lower ladder relative to said hull, a first indicator mounted to move vertically on said hull, a connection between said upper ladder at a point spaced from said first pivot and said first indicator moving said first indicator vertically relative to said hull as said upper ladder pivots relative thereto, a second indicator pivoted on said hull co-axial with said first pivot, an operating rod pivoted to said lower ladder and said second indicator and in cooperation with said upper ladder forming a parallelogram, a power driven endless bucket chain, means guiding said chain along said lower ladder for dredging and up along said upper ladder to said hull to carry dredged material to

said hull, and conveyor means operable to receive said dredged material from said bucket chains and carry it to a location for deposit.

4. A dredge comprising a hull, a unitary upper ladder pivoted at one end on said hull, a unitary lower ladder pivoted at one end thereof to the other end of said upper ladder, hoist means connected to adjust the vertical and angular position of said lower ladder relative to said hull, guide means on said ladders, an endless bucket chain movable in said guide means along both of said ladders and having a portion extending free of said guide means between said one end of said upper ladder and the other end of said lower ladder, tension wheels movable along said hull engaging said portion of said chain with a force providing a minimum tension therein, and a power drive connected to said chain at said one end of said upper ladder operable to pull said chain from said other end of said lower ladder to said other end of said upper ladder and therealong to said one end of said upper ladder.

5. A dredge comprising a hull, a unitary upper ladder pivoted at one end on said hull, a unitary lower ladder pivoted at one end thereof to the other end of said upper ladder, hoist means connected to adjust the vertical and angular position of said lower ladder relative to said hull, guide means on said ladders, an endless bucket chain movable in said guide means along both of said ladders and having a portion extending free of said guide means between said one end of said upper ladder and the other

end of said lower ladder, tension wheels movable along said hull engaging said portion of said chain, force means pressing said tension wheels against said chain with a force providing a minimum tension therein, and a power drive connected to said chain at said one end of said upper ladder operable to pull said chain from said other end of said lower ladder to said other end of said upper ladder and therealong to said one end of said upper ladder.

References Cited in the file of this patent

UNITED STATES PATENTS

8,840	Hamilton	Mar. 30, 1852
268,977	Angell	Dec. 12, 1882
484,763	Bowers	Oct. 18, 1892
503,655	Ellicott	Aug. 22, 1893
510,736	Urie	Dec. 12, 1893
530,675	Ball	Dec. 11, 1894
1,126,306	Sheppard	Jan. 26, 1915
2,147,062	Rosener	Feb. 14, 1939
2,178,265	Peterson	Oct. 31, 1939

FOREIGN PATENTS

352,997	Great Britain	Aug. 30, 1905
659,845	Great Britain	Oct. 31, 1951
457,364	Germany	Apr. 1, 1926
265,120	Italy	Nov. 3, 1928