This invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates generally to the adaptation of the principles of hydraulic grading for the subaqueous grading of banks composed of sand, clay or other earthy material and to an improved arrangement of the associated apparatus whereby the nozzles may be handled under water so as best to accomplish the desired purpose.

It is the primary object of this invention to provide apparatus for degrading banks of relatively loose material under water to permit the removal of the spoil either by river currents or mechanical means.

Another object of this invention is to provide an improved apparatus for controlling the nozzles whereby the loosened material is caused to become suspended in the water and the removal of the spoil facilitated.

Still another object of this invention is the provision of an improved arrangement for supporting the nozzles and equipment necessary for pumping of the water and maneuvering of the nozzles.

These and other objects and advantages of my invention will become apparent upon a consideration of the following description of an embodiment thereof when taken in conjunction with the accompanying drawings, in which—

Fig. 1 is a plan view of a subaqueous grader constructed in accordance with the principles of the invention;

Fig. 2 is an elevation of the grader;

Fig. 3 is an enlarged plan view of the nozzle header;

Fig. 4 is a side elevation of Fig. 3;

Figs. 5 and 6 are cross-sectional views along the lines 5—5 and 6—6 respectively, of Fig. 3;

Fig. 7 is a view, partly in cross-section, along the line 7—7 of Fig. 1;

Fig. 8 is a view in cross-section of a suitable clutch for use in conjunction with the operating apparatus;

Fig. 9 is a front elevation of Fig. 8, in which, for the purposes of clarity, the clutch operating arm has been eliminated;

Fig. 10 is a view, in cross-section, of a reciprocating water motor suitable for operating the nozzles; and

Fig. 11 is a view in cross-section of the water motor in the direction of the line 11—11 of Fig. 10.

Throughout the drawings similar elements have been designated with similar reference numerals.

Referring particularly to Figs. 1 and 2 it will be seen that I have provided a barge 1 having a deck 2 and a well 3. The operating apparatus is enclosed in a house 4. A ladder-like structure 5, hereinafter called ladder, is mounted in the well 3 and is pivoted at the barge end by means of bearings 6. The ladder 5 carries the water supply pipe 7 and the nozzle header 8. The ladder is raised or lowered by means of cable 9, which passes through a sheave 10 which, in turn, is supported by an A frame 12. The cable 9 leads to the winding drum 11. The drum 11 is driven from the main shaft 13 through the combined brake and clutch 14. The main shaft 13 is driven by means of the motor 15, which may be of any conventional type. In order that the barge 1 may be maneuvered so as to properly position the nozzle header 6, lines 16 pass through roller chocks 17, snatch blocks 18 to drums 19. The other ends of the lines 16 are attached to fixed points away from the barge 1. The drums 19 are each provided with a combined clutch and brake 20.

Water under pressure is provided for the nozzle header 6 by pumps 21 with a suction line 22 to valve 23 to a sea chest 24 and discharging into the supply pipe 7 supported on the ladder 5. Power for operating all equipment is furnished by Diesel generating plants 25 and associated switchgear 26.

The arrangement for mounting and controlling the nozzle header will be clear from a consideration of Figs. 3, 4, 5 and 6. The supply pipe 7 is connected to a T header 26. Upon the T header 26, at suitable intervals are placed swing joints 27, constructed so as to allow 120° free swing in a plane parallel to the axis of the T header 26. To the swing joint 27 are connected pipe arms 28 which are provided at their other ends with swing joints 29 to which the nozzles 30 are connected. The swing joints 29 allow a free swing of the nozzles 30 in a plane vertical to the axis of the T header 26. A reciprocating water motor 31, supported by a suitable bracket 41 and supplied with water from supply pipe 7 by means of water motor supply pipe 32, is arranged to reciprocate the cross bar 33. The swing joints 27 are provided with a lever 34 having a slotted end 35 adapted to be engaged by pin 36 placed in the desired hole 37 of the cross bar 33. The nozzles 30 are provided at their pivoted end with levers 38 carrying a locking bolt 39 adapted to engage the slotted quadrants 40.

Fig. 7 illustrates a preferred arrangement for
connecting the output of the pumps 21 to the supply pipe 7. The pump discharge outlet is connected to a stuffing box 42 provided with packing 43 and a follower 44. A trunnion pipe 45 is carried by trunnion bearing 46 supported by brackets 47. The T connector 48 on the supply pipe 7 is connected to pipes 49 fastened to the ladder 5. The pipes 45 are connected to the trunnion pipe 43 by means of flanges 50. Figs. 8 and 9 illustrate a preferred clutch and brake for use in operating the drums 11 and 19. The gear 51, running free on the main shaft 13 by means of bearings 52, is keyed to the member 53 carrying the brake drum 54 and peripheral clutch face 55. The clutch operating mechanism is carried by a drum 56 keyed to the main shaft 13. The brake shoes, which have been omitted for the purposes of clarity, are carried by the bracket 57 on the main bearing support 58. A stud 59 carried on the drum 56 engages one end of the clutch band 60, the other end of which is engaged by the adjusting member 61. The clutch lever 67 is divided and connected to the clutch by means of links 62 which engage pins 63 of member 64 which runs free in a groove 65 in sliding collar 66. The collar 66 also carries pins 60 which engage links 63, the other ends of which, by means of pins 51, engage operating arms 70 keyd to shaft 72 supported in bearings 73. Also keyed to the shaft 12 is a lever arm 74 connected to an adjustable arm 75 which, in turn, is connected to a link 76 pivoted to drum 75 by a stud 77. The link 76 is connected to link 78 by means of pin 73 and is arranged to be engaged by the adjustable stop 80. The other end of the link 78 engages one arm of a bell crank 81 pivoted about stud 82. The other arm of the crank 81 is pivotally attached to the adjustable member 61. Adjusting members 83 are provided about the periphery of the clutch at suitable intervals. A stop 84 on the shaft 13 is provided to limit the movement of the clutch lever 67.

It will be apparent that with the clutch lever in position against the stop 84 the adjustable arm 75 will be up and the bell crank 81 in its counter-clockwise position. As the clutch lever is moved towards the member 56 the arm 75 will be moved downward and impart a clockwise rotation to the bell crank 81. The rotation of the crank 81 will tighten the clutch band forcing the clutch facing 85 into contact with the clutch face 85 imparting rotation to the member 53 and consequently the gear 51.

Figs. 10 and 11 illustrate a water power motor suitable for operating the nozzles. The motor consists of a cylinder 86 provided with a main valve 87 and an auxiliary valve 88. Water enters the auxiliary valve cylinder 89 through port 90 and passes to one face of the main valve operating piston 91 through channels 92. The entering water causes a movement of the piston 91 and this movement causes the other face of the piston 91 to eject the water above it through the corresponding channel 93 and exit port 94. Flanges 95 on the shaft of piston 91 engage the main valve 87 and impart a corresponding movement to said valve uncovering one of the main inlet channels 95 and the opposite outlet channels 97. The water entering the cylinder 89 causes a movement of the main piston 96. This movement, in turn, causes the under face of the piston 96 to eject the water above it through outlet channel 97 and exhaust port 92. The movement of the piston is imparted to the cross bar 93 by means of piston rod 98. The position of the auxiliary valve 97 is controlled by shaft 99, which in turn, is controlled by the lever 100 connected to the piston rod 98. The lever 100 and the shaft 99 are arranged on guide bars 101 so that a reversal of motion occurs at the end of each stroke of the main piston.

In operation the barge 1 is towed to the point of use and lines 11 fastened to suitable mooring posts. The nozzles 30 are adjusted by means of the levers 33 and quadrants 40 so as to have the proper angle when the ladder 5 is lowered. They are angularly positioned by connecting the levers 34 to the proper holes 37 in the cross bar 31. The ladder 5 is then lowered by means of the brake on drum 11 and a manipulation of the clutches 20 operating drums 19 will position the barge. If desired, the clutches and brakes may be remotely controlled from the switchgear 26.

After the header 8 is in position the pumps 21 are started and water ejected from the nozzles 30. The water motor 31 will be actuated and the reciprocating motion of the cross bar 33 will cause an oscillation of the nozzles in a plane corresponding to that in which they were placed by the quadrant adjustment. Reciprocating oscillation of the drums 19 will cause the barge to be maneuvered so that the desired dredging operations may be carried out. It will be appreciated that the constant movement imparted to the nozzles 30 will cause a continual agitation of the water and, consequently, the material dissolved will tend to remain in suspension for a much longer period than would be true were the nozzles fixed. Where there are strong currents the particles in suspension will be carried away by natural means; it is obvious, however, that should the current not be strong enough for such a purpose suction dredge may be used. New mooring positions are used after the barge 1 has operated within the limits of the lines 16 until the desired dredging operation has been completed. After completion of the project the lines 16 are reel out, the pumps 21 turned off and the ladder raised to its uppermost position within the well 3 when the barge is ready to be transported to a new location.

Although I have described my invention with particularity in connection with a single embodiment thereof it is to be understood that I do not wish to be limited to the particular arrangements disclosed since various modifications within the spirit of the invention will suggest themselves to one skilled in the art.

Having described my invention what I claim as new and which I wish to secure by Letters Patent is:

1. A submersible grader comprising a vessel, a submersible supply pipe having one end pivoted to said vessel, a header carried by the free end of said submersible member, said header being arranged transversely to said supply pipe, a nozzle pivotally attached to said header, means to raise and lower said submersible supply pipe, means to adjust said nozzle to a predetermined vertical angle while said submersible supply pipe is in its raised position, means to oscillate said nozzle in a plane parallel to said header while submerged, and means to force fluid from said nozzle.

2. A submersible grader comprising a vessel, a submersible supply pipe pivotally attached to said vessel, a header mounted on the end of said supply pipe to be submerged, said header being arranged transversely to said supply pipe, a nozzle pivotally attached to said header, means to raise and lower said submersible supply pipe, means to angularly adjust said nozzle in a vertical plane
and in planes parallel to said header, means to oscillate said nozzle in a plane parallel to said header while submerged, and means to force fluid through said nozzle.

5. A subaqueous grading apparatus comprising a submersible supply pipe arranged to be lowered to a fixed position, a header carried by said supply pipe, said header being arranged transversely to said supply pipe, a nozzle provided with a lever and pivotally attached to said header, means to raise and lower said submersible supply pipe, means to adjust said nozzle to a predetermined vertical angle while said submersible supply pipe is in its raised position, means to oscillate said nozzle in a plane parallel to said header while submerged, said oscillating means being attached to said lever, and means to force fluid from said nozzle.

4. A subaqueous grading apparatus according to claim 3 in which said lever is adjustable connected to said oscillating means, whereby the field of oscillation of said nozzle may be varied.

5. A subaqueous grader comprising, a vessel, a submersible supply pipe having one end pivoted to said vessel, a header carried by the free end of said submersible member, said header being arranged transversely to said supply pipe, a plurality of nozzles pivoted to said header, means to raise and lower said supply pipe, means to individually adjust said nozzles to predetermined angles in a vertical plane and in a plane parallel to said header while said header is in its raised position, means to oscillate said nozzles in a plane parallel to said header while submerged, and means to force fluid from said nozzles.

6. A subaqueous grader comprising, a vessel, a submersible supply pipe pivotally attached to said vessel, a header mounted on the end of said supply pipe to be submerged, said header being arranged transversely to said supply pipe, a plurality of nozzles pivoted to said header, means to raise and lower said submersible member, means to individually angularly adjust said nozzles in a vertical plane and in a plane parallel to said header, means to oscillate said nozzles in a plane parallel to said header, and means to force fluid through said nozzles.

JAMES D. ANDREWS, Jr.