March 2, 1965 J. L. SCHRAM 3,171,220

SUCTION DREDGE HAVING ROTATABLE DIGGING TOOL

Filed May 2, 1962 3 Sheets-Sheet 1

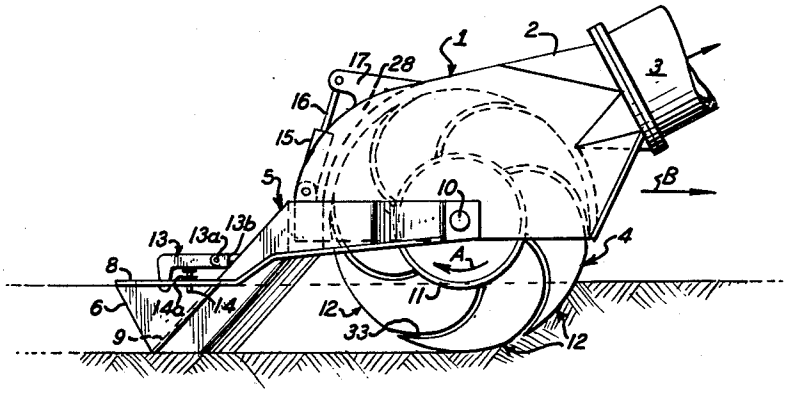


Fig. 1

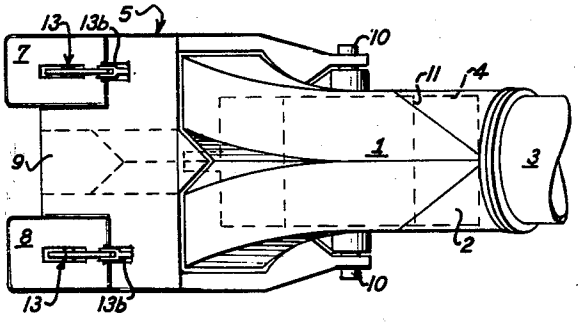


Fig. 2

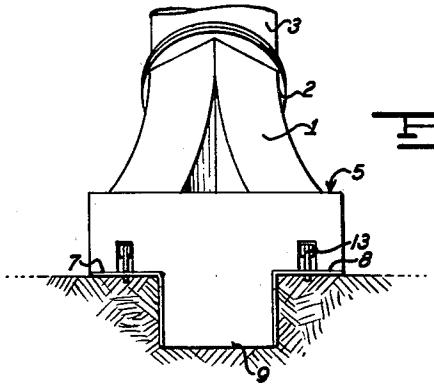


Fig. 3

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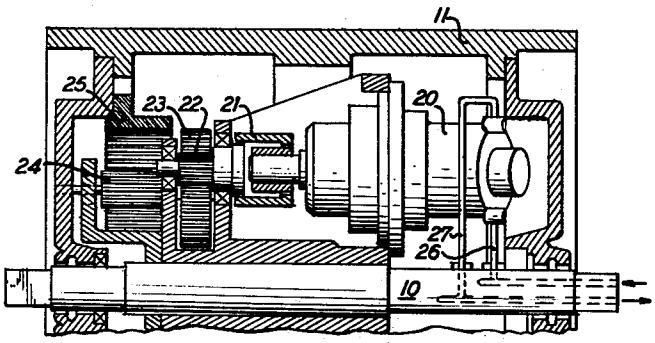


Fig. 4

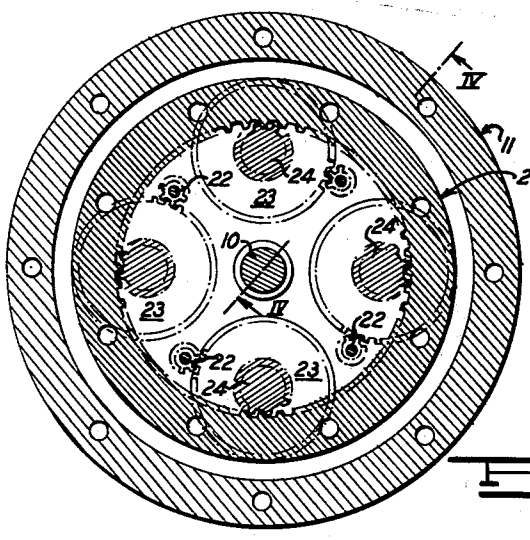


Fig. 5

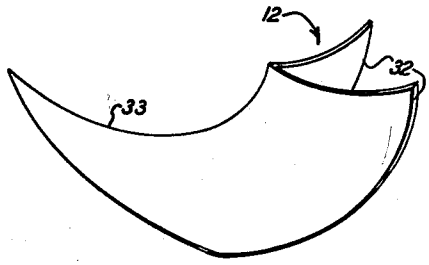


Fig. 6

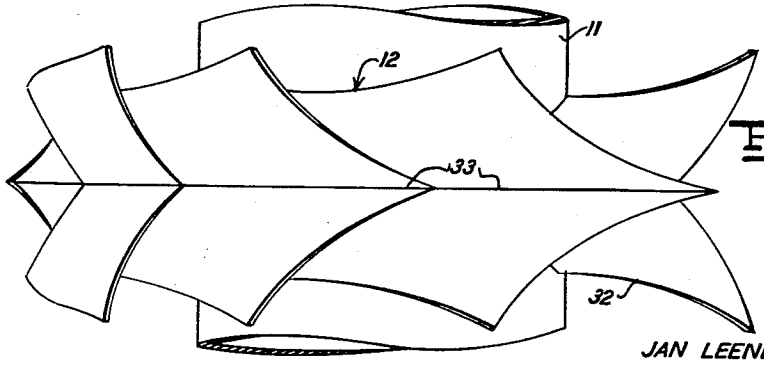


Fig. 7

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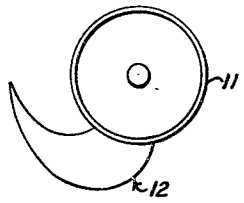


Fig. 8

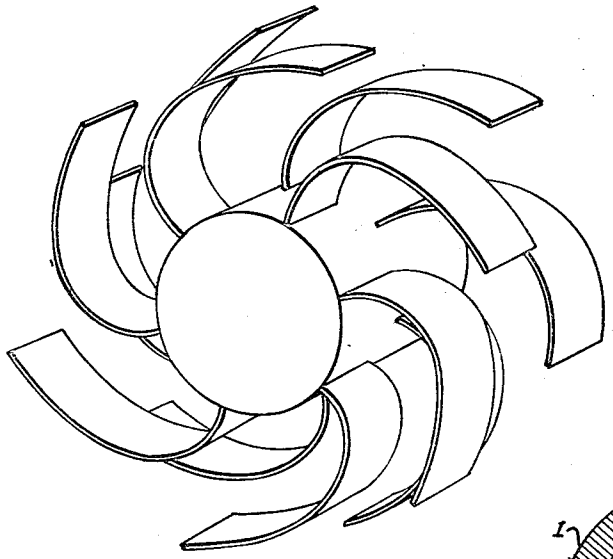


Fig. 11

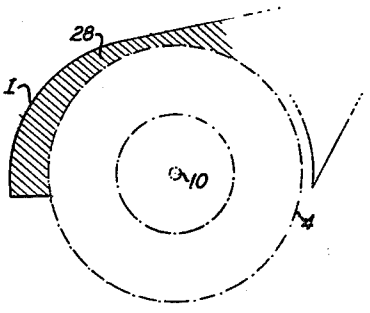


Fig. 9

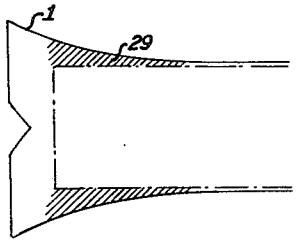


Fig. 10

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SUCTION DREDGE HAVING ROTATABLE DIGGING TOOL

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7 Claims. (Cl. 37—66)

The invention relates to suction dredges.

It is contemplated that suction dredges according to the invention will include a suction tube, ending in a hood with a suction aperture, and a rotatable digging tool proximate the suction aperture. In sandy soils a suction tube without a digging wheel operates rather satisfactorily, but as soon as the sand is mixed with loam or silt the quantity of sucked earth per unit volume of sucked water becomes greatly reduced due to the density and compactness of the loam and silt whereby the machine becomes relatively inefficient. The mere addition, however, of a rotatable digging tool does not substantially improve the above devices, it being necessary that the digging tool be integrated in a particular manner.

It is an object of the invention to combine digging means with suction means to provide for improved dredging operation. In a known class of dredges with digging or cutting tools the reaction force of the cutting tool on the craft requires that the latter be anchored and stationary. In the present invention, however, the digging tools do not affect the mobility of the craft.

It is an object of the invention, while retaining the principle of mobility, to improve the efficiency of dredging without substantial power requirements. According to the invention there is provided at the end of a suction tube, hood means which encloses the upper half of the digging tool and which defines therewith a radial and axial spacing. Furthermore, the suction tube tangentially adjoins the upper part of the digging tool and the direction of flow of the water in the hood corresponds to the direction imparted by the digging tool to the excavated lumps of earth, such that a maximum quantity of ground per unit volume of water is fed through the suction tube. The suction force within the hood is concentrated in the hindmost part of the hood and propagates in the area along the inner side of the hood toward the connection of the suction tube, the foremost and middle part of the hood being obstructed by the hub 11 and the digging tools.

In further accordance with the invention the water which is sucked by the suction tube flows through the digging tool and consequently entrains the excavated earth.

It is another object of the invention to concentrate the flow of the water by the suction into rapidly moving streams and to prevent a loss of efficiency. To achieve a suitable support for the suction tube there is mounted on the hindmost portion of the hood a segment, which is rotatably adjustable about the rotational axis of the digging tool. Not only does this provide a closing off of the hindmost portion of the hood and induce only lateral water entry into the hood, but moreover it provides a supporting surface for the end of the suction tube through the hood with the digging tool.

A further object of the invention is to provide adjustable elements at the location of the hindmost portion of the segment which can contact the ground, the said elements being capable of penetration into the ground for exerting a braking action.

Another object of the invention is to provide a hydraulic driving gear in which the driving means are not in

contact with the water and the ground, thus avoiding an important source of wear and disturbance.

These and other objects and features of the invention will be more readily understood and appreciated from the following detailed description of a preferred embodiment of the excavating-suction assembly shown in the accompanying drawings, in which

FIG. 1 is a side elevation of the dredging apparatus showing only a portion of the suction tube,

FIG. 2 and FIG. 3 are respectively a plan view and a rear elevational view of the apparatus in FIG. 1,

FIG. 4 is a longitudinal section along the line IV—IV in FIG. 5,

FIG. 5 is a cross section and view through the hub showing the mechanism for driving the hub, with some details left out for simplification,

FIG. 6 is a perspective view of a first cutting element,

FIG. 7 is a plan view of a hub with the cutting elements supported thereon,

FIG. 8 shows a hub on which a single helical cutting element is shown for purposes of illustration in side elevational view,

FIG. 9 shows in cross hatching the radial space between the hood and the digging tool which is shown in dotted outline,

FIG. 10 shows in cross hatching the axial space between the hood and the digging tool which is shown in dotted outline, and

FIG. 11 is a perspective view of a second embodiment of a digging tool.

In FIG. 1 there is shown a hood 1, provided with a connection 2 for a suction tube 3. Within the hood 1 is rotatably supported a digging tool 4, while rearmost on the hood there is provided a segment 5, which is pivotally supported around the rotational axis of the digging tool 4. The hood 1 is formed in such a way that it encloses slightly more than the upper half of the digging tool 4. The hood has a curved outline radially offset from the contour of the tool 4 in a direction away from the connection 2 such that a radial space 28 is formed between the outer circumference of the digging tool and the hood as best seen in FIG. 9 while the hood includes tapering portions extending laterally of the tube to define between the hood and the contour of the tool an axial space 29 as best seen in FIG. 10. The connection 2 for the suction tube 3 is positioned in such a way that there is obtained a tangentially directed opening in the connection 2 with respect to the upper part of the digging tool 4. The radial and axial spaces gradually diminish towards the suction tube 3. The purpose of this decrease will be explained hereinafter.

The rearmost portion 6 of the segment 5 contacts the bottom of the trench which is cut by the tool 4. Two lateral wings 7 and 8 protrude on either side of a central portion 9 which lies therebetween. As best seen in FIG. 3 the lateral wings 7 and 8 are situated above portion 9, the difference in height being equal to the maximum digging depth of the tool 4. The lateral wings 7 and 8 constitute a supporting surface for the assembly composed of the hood 1 with the digging tool 4. When the lateral wings are supported on the surface to be dredged, the depth of the cut of the digging tool is determined.

The central portion 9 of the segment 5 is also shaped as a flat surface, which is substantially tangentially directed with respect to the circular contour defined by the outermost parts of the digging tool 4 (see FIG. 1).

The digging tool 4 is constituted by a hollow hub 11 mounted for rotation on a shaft 10, and a ring of shovel-like elements 12 secured along the circumference of the hub. The shovel-like element 12 cut the earth and left the same upwardly to the hood 1.

The digging tool 4 is shown with six shovel-like elements 12 each consisting of two thin symmetrical parts joined along a rib or edge which forms a leading edge 33 for the elements 12. The thin symmetrical parts constitute side portions which extend in helically curved fashion from the leading edge portion to form a generally V-shaped element. The leading edge portions extends from the hub 11 with decreasing curvature in a forward direction relative to the direction of rotation of the hub. The curvature of the leading edge portion is characterized by following an involute path which is developed in the direction of rotation.

The helical curvature of the side portions of the shovel-like elements is best seen in FIG. 6 wherein a single blade is shown for purposes of clarity. The helical curvature causes discharge of soil in a lateral direction during rotation of the digging tool and promotes discharge of the soil into the stream of water in the axial spaces 29 in the hood 1.

The shovel-like elements 12 are regularly arranged in angular fashion around the hub and as seen in a side elevational view the leading portions of each element lie adjacent the trailing edge portion 32 of a preceding element. The side portions are shaped thus, that in a section taken in a plane perpendicular to shaft 10 the side portions extend involutely from the shaft in correspondence with the leading edge portions 33 of an adjacent element such that the spacing between adjacent elements is uniform and continuous.

The curvature and the length of each shovel-like element are selected such that prior to withdrawal of the leading edge of each element from the ground the leading edge of the next shovel element enters the ground. This can best be seen in FIG. 1 wherein there are shown three blades simultaneously in the ground. The leading or central edge (or rib) 32 of each blade lies in correspondence with the open trailing portion of the previous blade.

The cutting edges of the elements 12 are situated in a cylindrical surface which is coaxial with the shaft 10, so that a substantially continuous outer periphery is formed by the blades. The continuous contact of the elements 12 with the ground results in a resistance to the tool which fluctuates but slightly and which to a great extent contributes to a smooth propulsion of the dredging apparatus.

The digging tool 4 may also have the shape of two adjacent sets of six blades, the cross section of which perpendicular to the rotational axis is an involute, developed in the direction of rotation. The generatrices of these blades instead of being helically curved are straight lines, parallel to the rotational axis. Each blade subtends an arc of about 60° and the sets of blades are angularly staggered by 30° relative to one another, so that there is at least one, and generally two blades penetrating into the ground, thus equalizing the resistance forces.

Disposed at the location of the lateral wings 7 and 8 are elements 13 each of which are pivotally supported at a pivot 13*a* to a member 13*b* which is rigidly secured to the segment 5 as seen in FIGS. 1 and 2. The elements 13 pass through openings in the wings 7 and 8 to penetrate into the ground for exerting a braking action on the forward movement of the dredge. The depth at which each of these elements penetrate into the ground can be adjusted by means of an associated arrangement constituted by a screw-rod 14 which is threadably engaged in a nut 14*a*. The nuts 14*a* are rotatably supported at a fixed level on wings 7 and 8 while rods 14 are secured to elements 13. Consequently as a nut 14*a* is rotated the rod 14 engaged therein will be axially displaced whereby the element 13 will be pivotally moved about pivot 13*a* to thereby be raised and lowered with respect to the wings 7, 8 to vary the degree of penetration through said wings. The height of the segment 5 can also be adjusted and to that end there is disposed an adjusting cylinder 15, the piston rod 16 of which is hingedly connected with a fixed

protruding member 17 on the hood 1. This adjusting cylinder has been deleted in the plan view of FIG. 2 and in the back elevational view of FIG. 3 for purposes of clarity.

The digging tool 4 is driven in the direction of the arrow A by means of a hydraulic mechanism which is accommodated in the hollow hub 11. This arrangement is shown in FIG. 4 and FIG. 5. The driving mechanism consists of four hydraulic engines 20, which are mounted on the fixed central shaft 10. The output shaft of each engine 20 is connected with a pinion 22 by way of a coupling 21, allowing for play, the pinion 22 being supported in two flanges of a frame, which is fixedly secured on the shaft 10. Each pinion 22 drives a toothed wheel 23, forming one piece with a pinion 24. The four pinions 24 engage a rim 25 provided with inner toothing. This rim 25 is fixedly connected with the hollow hub 11. Pressure medium is fed to the engines 20 by way of the ducts 26, the discharge medium being returned by way of a duct 27. The latter ducts open into bores in the central shaft 10. Provided at the front faces of this shaft are connections (not shown) for ducts, leading to a pump on the craft of the suction dredge.

The device operates as follows. After lowering the dredging apparatus to the ground to be dredged, the circumference of the rotating digging tool first contacts the ground. The shovel elements 12 penetrate into the ground since portion 9 so permits. If now the craft of the suction dredge moves forward (in the direction indicated by the arrow B) the digging tool will gradually dig itself into the ground, and during this period the depth of the gulley or trench to be dug gradually increases. The portion 9 of the segment 5 keeps following in the trench until the maximum depth of digging is reached while the lateral wings 7 and 8 contact the ground on either side of the trench. Meanwhile the suction pump aboard the craft is actuated and water is sucked upwardly through the suction tube 3. Lumps of earth are cut away and conveyed upwardly by the shovel elements 12. The lumps move gradually laterally of the shovel element, the lumps being deposited into the slit shaped spaces on either side of the digging tool 4 within the hood 1, in which spaces a strong suction current in the direction of the tube 3 has been establised. Consequently, the earth will be carried along by the water, so that the entire volume of the excavated lumps is washed from the shovel elements 12 before these elements leave the hood 1.

When the digging tool 4 is driven at a sufficient speed the lumps in the shovel elements 12 will be directed radially and deposited in the radial slit shaped space 28 under the action of centrifugal force, where they are urged along by the flowing water to the tube 3. The tangential positioning of the connection 2 for the suction tube 3 permits the excavated earth to be moved along free from resistance with the water. The rotation of the digging tool 4 supplements the action of the suction pump aboard the craft by helping to move the earth to the suction tube.

It has been proven that the efficiency of the dredging apparatus, that is, the ratio of the quantity of earth carried along per unit volume of water is markedly greater than in known suction dredges, especially when there is loam or silt in the ground.

The angular position of the segment 5 with respect to the hood 1 is adapted to the inclination of the suction tube 3, which in turn bears a certain relationship to the length of tube and the depth of the ground to be dredged. This angular position is such, that, as the circumference of the digging wheel touches the ground, the portion 9 is not yet in contact with the ground.

In the use of the suction dredge the digging tool 4 will exert a reaction force on the craft in the direction of the arrow B. Under certain circumstances it may be desirable to diminish slightly this propulsive force for which purpose the braking elements 13 are effective. If it is desired to decrease the depth of excavation this can be achieved

by changing the position of the adjusting cylinder 15 such that the segment 5 is moved downwardly through a small angle whereupon during further forward movement the digging tool gradually moves upwards.

What is claimed is:

1. Suction dredging apparatus comprising a digging tool supported for rotation, said digging tool having an outer circular contour, means for rotatably driving the digging tool, a hood partially enclosing the digging tool, a suction tube, connection means establishing communication between the suction tube and the hood for applying a suction within the hood, said connection means opening into said hood tangentially with respect to the outer contour of the digging tool, said hood having a curved outline radially offset from the contour of the tool in a direction away from the connection means such that said tool is supported within said hood to define a radial space therein which is in communication with the opening between the suction tube and the hood and which diminishes towards the suction tube, said hood including tapering side portions extending laterally of the tool to define an axial space between the hood and the contour of the tool which is also in communication between the opening between the suction tube and the hood and which diminishes towards the suction tube.

2. Suction dredging apparatus comprising a digging tool, means for driving said digging tool in rotation, said digging tool having an outer circular contour, a hood enclosing more than half the digging tool, a suction tube, connection means establishing communication between the suction tube and the hood for applying a suction within said hood, said connection means opening into said hood tangentially with respect to the outer contour of the digging tool, said hood having a curved outline radially offset from the contour of the tool in a direction away from the connection means such that said tool is supported within said hood to define a radial space therein which is in communication with the opening between the suction tube and the hood and which diminishes towards the suction tube, said hood including tapering side portions extending laterally of the tool to define an axial space between the hood and the contour of the tool which is also in communication between the opening between the suction tube and and the hood and which diminishes towards the suction tube, a segment pivotally supported with respect to said hood and extending in a direction away from said suction tube, said segment comprising a central portion having a surface extending substantially tangential to the outer contour of the digging tool and laterally extending wings at a higher elevation than said central portion, and adjustable means connecting said segment to said hood for varying the angular position of the segment with respect to said hood.

3. Suction dredging apparatus adapted for being propelled in a direction of travel, said apparatus comprising a fixed shaft, a hub surrounding said shaft, means for rotating said hub, a plurality of cutting elements secured to said hub for rotation therewith, each element including a leading edge portion and outwardly curved side portions extending from the leading edge portion to form a generally V-shaped element, said leading edge portion extending from said hub with decreasing curvature in the direction of rotation of the hub, said cutting elements being aligned in a plane perpendicular to the hub and being regularly arranged angularly with respect to said hub such that the leading edge portion of each element lies adjacent the trailing edge portion of an adjacent element and the elements cooperatively define a substantially circular outer contour, a hood enclosing more than half the cutting elements, a suction tube, connection means establishing communication between the suction tube and the hood for applying suction within said hood, said connection means opening into said hood tangentially with respect to the outer contour of the digging tool, said hood having a curved outline radially offset from the contour of the tool in a direction away from the connection means such that said tool is supported within said hood to define a radial space therein which is in communication with the opening between the suction tube and the hood and which diminishes towards the suction tube, said hood including tapering side portions extending laterally of the tool to define an axial space between the hood and the contour of the tool which is also in communication between the opening between the suction tube and the hood and which diminishes towards the suction tube, a segment pivotally supported from said shaft and extending rearwardly relative to the direction of travel of the apparatus, said segment comprising at the rear thereof a central portion having a surface extending substantially tangential to the outer contour of the cutting elements and laterally extending wings at a higher elevation than said central portion, adjustable means connecting said segment from said hood for varying the angular position of the segment with respect to said hood, and adjustable elements extending through said wings, said wings and said central portion establishing by the difference of the level therebetween the depth of penetration of the cutting elements into the ground to be dredged, said wings resting on the ground as said cutting elements penetrate thereinto, to a depth limited by the central portion of the segment, said adjustable elements extending through said wings to also penetrate the ground and thereby exert a braking force, said hub being rotated in a direction to provide a linear component which is rearwardly directed at the location where the cutting tool is in contact with the ground.

4. A suction dredge according to claim 3, wherein the means for rotating said hub is contained therewithin.

5. A suction dredge according to claim 4, wherein said means for rotating said hub comprises at least two hydraulic motors evenly distributed along the inner circumference of the hub and secured on said shaft, and means in driving relation with the motors and the hub for driving the latter from the motors.

6. A suction dredge according to claim 5 wherein a pair of longitudinal bores are provided within the fixed central shaft, the said bores on one side thereof terminating adjacent a front face of the shaft and adapted for connection with a hydraulic pump, said bores on the other side thereof terminating at a location whereat the shaft is within the hub, the dredge further comprising feed and discharge ducts for hydraulic medium connected to said hydraulic motors, said bores being connected to said feed and discharge ducts.

7. Suction dredging apparatus comprising a fixed shaft, a hub surrounding said shaft, means for rotating said hub, a plurality of cutting elements secured to said hub for rotation therewith, each element including a leading edge portion and curved side portions extending from the leading edge portion to form a generally V-shaped element, said leading edge portion extending from said hub with decreasing curvature in the direction of rotation of the hub, said cutting elements being aligned in a plane perpendicular to the shaft and being regularly arranged angularly with respect to said hub such that the leading edge portion of each element lies adjacent the trailing edge portion of an adjacent element and the elements cooperatively define a substantially circular outer contour, a hood enclosing more than half the cutting elements, a suction tube, connection means establishing communication between the suction tube and the hood for applying suction within said hood, said connection means opening into said hood tangentially with respect to the outer contour of the elements, said elements being supported within said hood to define radial and axial spaces therewith, a segment pivotally supported from said shaft and extending in a direction away from suction tube, said segment comprising a rearmost portion including a central portion and laterally extending wings at a higher elevation than said central portion, adjustable means connecting said

segment from said hood for varying the angular position of the segment with respect to said hood, and adjustable elements extending through said wings, said wings and said central portion establishing by the difference of the level threbetween the depth of penetration of the cutting elements into the ground to be dredged, said wings resting on the ground as said cutting elements penetrate thereinto, said adjustable elements extending through said wings to also penetrate the ground and exert a braking force.

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