A bulldozer adapted to carry out operations on ground which is submerged beneath water. The existing frame and belly guard of a conventional bulldozer are interconnected so as to form a watertight enclosure in which the engine and additional components are housed. At the upper part of the enclosure is a support for the operator and the various controls are accessible to the operator at the upper part of the enclosure. All liquid-holding tanks are located at an elevation sufficiently high to prevent flooding thereof, and the intake and exhaust of the engine also extend to an elevation high enough to maintain them out of water in which the entire bulldozer is situated during underwater operations.

1 Claim, 9 Drawing Figures
BULLDOZER FOR UNDERWATER OPERATIONS

BACKGROUND OF THE INVENTION

The present invention relates to bulldozers. In particular, the present invention relates to bulldozers which are adapted to carry out operations on ground surfaces which are submerged beneath water.

When it is required to carry out underwater operations with a bulldozer, difficulties are encountered with conventional bulldozers when the depth of water becomes substantial. For example, with conventional bulldozers it is possible to carry out dredging operations, for example, in the water as long as the depth thereof does not exceed approximately 4 feet. However, when the depth of water becomes greater it is not possible to operate a bulldozer to carry out ripping, moving, dredging, or crushing operations. With conventional bulldozers if the engine or other parts thereof should become submerged, flooding of water takes place in a manner which will prevent the bulldozer from continuing to operate. In addition, such water flooding of engine and other components can create serious and permanent damage to the engine and other parts, particularly in cases where the water has a chemical composition which is deleterious to the engine and other components, such as in the case where a water of high salinity is encountered. The resulting overhauling of the engine and the other components is extremely expensive and economically unsound. As a result, it is not practically possible to operate with conventional bulldozers in depths of water which are substantially greater than approximately 4 feet.

Of course, there are known systems for carrying out operations, such as dredging operations, in depths of water which may be over ten feet. For example, it is known to provide suction dredging equipment which floats on water. However, such equipment is expensive and involves a high operating cost as well as a high cost in mobilizing and demobilizing such equipment. The use of such equipment is limited to dredging relatively deep water. The equipment cannot be used for other purposes. Such equipment cannot be used in shallow water because of the draft and operational requirements of such equipment.

Also, it is known to carry out dredging operations by using a crane and bucket which are mounted on a barge. The operation of such equipment is slow and time consuming, and such operations are limited to mud and sand excavation. This type of equipment requires a tug and a dump barge along with the crane barge.

The disadvantages encountered with this type of equipment are numerous. Not only is such equipment expensive with respect to its original cost, but also high operating costs and high mobilization and demobilization costs are encountered. Furthermore, the equipment is limited to dredging relatively deep waters and cannot be used for other purposes. In this case also the equipment cannot be used in shallow water because of the draft and operational requirements.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide equipment capable of carrying out operations such as dredging operations not only in relatively shallow water but also at depths which may extend up to approximately 20 feet.

In addition it is an object of the present invention to provide a structure of this type which is simple to operate, which is relatively inexpensive, and which can be used not only for dredging but also for a wide variety of additional purposes.

In particular, it is an object of the present invention to provide a bulldozer which is constructed so that it can operate very reliably not only on a dry surface at zero depth of water, but also in water at depths of up to approximately twenty feet.

Thus, it is an object of the present invention to provide a bulldozer structure of this type which is rugged and simple to operate and at the same time is capable of carrying out ripping, crushing, moving, as well as dredging operations, the bulldozer being capable of transferring loose as well as continuous hard-surfaced materials from one location to another.

It is furthermore an object of the present invention to provide a bulldozer structure which can be used for pushing or pulling barges, floats, and other equipment of the latter type, in, above, and underwater.

Furthermore, it is an object of the present invention to provide a bulldozer which readily lends itself to purposes such as forming trenches, laying pipes and hauling materials underwater.

In particular, it is an object of the present invention to provide a structure which can be carried out with relatively simple inexpensive alterations of existing bulldozer structure.

Furthermore, it is an object of the present invention to provide a construction of this type which enables the operator to know how the bulldozer is operating at the surface beneath the water.

Furthermore, it is an object of the present invention to provide a bulldozer structure which can be readily serviced and adjusted, even though it is fully capable of efficiently carrying out underwater operations.

According to the invention the bulldozer includes an engine and components which operate together with the engine to bring about the required bulldozer operations. An upper support means is provided at an upper part of the bulldozer to carry the operator, and the controls are accessible to the operator at the upper support means. A watertight enclosure means extends downwardly from the upper support means and forms an interior hollow space in which the engine and the other operating components are enclosed in a watertight manner so that the bulldozer can operate very effectively in relatively substantial depths of water.

BRIEF DESCRIPTION OF DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a simplified schematic perspective illustration of a bulldozer of the invention during operation thereof;

FIG. 2 is a side view of the bulldozer, schematically represented during operation in a substantial depth of water;

FIG. 3 is a front view of the bulldozer of FIGS. 1 and 2, with the front blade attachment removed;

FIG. 4 is a rear view of the bulldozer of FIGS. 1 and 2, with the ripper attachment removed;

FIG. 5 is a fragmentary side elevation of the enclosure means of the bulldozer of the invention, taken along line 5—5 of FIG. 3 in the direction of the arrows;
FIG. 6 is a fragmentary transverse sectional elevation, taken along line 6—6 of FIG. 5 in the direction of the arrows, and showing at a scale which is enlarged, as compared to FIG. 5, details of a connecting means for removably connecting a cover to the enclosure means in a watertight manner;

FIG. 7 is a fragmentary sectional illustration of the manner in which a watertight connection is achieved between components at one part of the bulldozer;

FIG. 8 is a fragmentary sectional elevation illustrating how watertight connections are provided at another part of the bulldozer; and

FIG. 9 is a fragmentary schematic partly sectional illustration of the manner in which an indicator of the invention is connected to the swingable blade/bucket assembly for indicating the position thereof even though submerged.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings, there is shown in FIG. 1 a bulldozer 10 of the present invention. This bulldozer 10 has an upper support means 12 which is situated at a height of at least 20 feet above the ground on which the bulldozer rides. As is clear from FIGS. 1—4, the illustrated bulldozer is of the type which has endless tracks 14, and the upper support means 12 will be situated at a height of approximately 20 feet above the lower runs of the tracks 14. This support means 12 includes, for example, a horizontal plate 16 carried by suitable supports 18 and situated at the height of approximately 20 feet above the ground on which the tracks 14 ride. The floor which is formed by the plate 16 of the upper support means 12 serves to carry a seat 20 for the operator, and it will be noted that various controls 22 are freely accessible to an operator occupying the seat 20. These controls will operate various units located in a suitable housing 24, and liquid tanks, such as a tank 26 for fuel are all situated on the upper support means 12 to be maintained above the water which can rise all the way up to the elevation of the upper support means 12, as is apparent from FIGS. 2—4, so that in this way any danger of flooding a tank 26 or the like, or access of water to control assemblies in a housing 24 are reliably avoided. At the same time the operator being situated well above practically all components of the tractor can readily oversee all of the operations in an exceedingly effective manner.

The bulldozer is provided with conventional frame elements such as the metal walls 28 provided with suitable rungs 30 to enable the operator to operator to climb up and down the bulldozer. The walls can be reinforced with box stiffeners 32.

The front of the frame for the bulldozer includes a rugged solid wall 34 having rearwardly extending side flanges 36, and a similar wall 38 is situated at the rear. These frame walls 28, 34, and 38 carry the upper support means 12 and extend downwardly therefore. These walls 28, 34, and 38 are made of metal and are thus watertight, so that they are capable of surrounding a space beneath the support means 12 in watertight manner.

The bulldozer is provided with a front attachment 40 which serves as a blade. Thus, the front attachment 40 has a blade 42 which extends between and is fixed to a pair of rugged side plates 44, so that the blade means 40 will also operate as a bucket. This attachment 40 is supported for swinging movement by way of suitable rods 46 and pivot attachments 48. It is hydraulically operated by the use of swingable hydraulic piston-and-cylinder assemblies 50 which are well known in the art, and the oil or other liquid under pressure is supplied to and from the assemblies 50 by way of flexible pipe or hose material 52 which extends in a watertight manner through suitable fittings 56 provided in the walls 28.

The rear ripper attachment 58 is conventional and is also operated by way of hydraulic flexible conduits 60 which extend through the rear wall 38 in a watertight manner through the use of suitable glands or fittings such as the fittings 56.

During operation of the bulldozer in any substantial depth of water, the entire blade attachment 40 may be submerged and invisible to the operator. Therefore, one of the swingable hydraulic assemblies 50 is provided with a plate 62 which serves to operate an indicating means 64, details of which are also shown in FIG. 9. Thus, as may be seen from FIG. 9, the plate 62 is formed with a slot 66 in which a rod 68 is freely slidably forwardly and rearwardly, and this rod is situated at the lower end of the elongated upright rod assembly 70 guided through suitable tubular fittings such as the fitting 72 carried by one of the stiffener elements 32. Thus, as the blade swings up and down the indicating rod 70 will rise and fall, and by any suitable means such as comparing the position of the rod 70 with a rod 74 the operator can visually determine the angle and elevation of the blade even though it is submerged.

The frame components 28, 34, and 38, form, in a manner described in greater detail below, part of a watertight enclosure means of the invention in which the engine and other operating components are housed. However, the engine is provided with intake and exhaust pipes which extend well above the elevation of the upper support means 12. FIGS. 1—4 illustrate the intake 76 and the exhaust 80 of the engine. These pipes have upper open ends situated well above the upper support means 12, so that there is no danger of any water entering the engine through the intake or exhaust thereof.

Referring now to FIG. 5, the side walls 28 are connected to a belly guard 82. This belly guard has a lower wall and side walls which diverge upwardly from the lower wall and are normally connected to the existing frame conventionally found on a tractor or bulldozer and formed in this case by the walls 28 as well as the front and rear walls 34 and 38. However, in accordance with the present invention the conventional belly guard 82 is modified so that water cannot pass therethrough, and the connection between the belly guard and the existing frame components is rendered watertight as by providing a welded connection therebetween.

If convenient the free edges of the belly guard may be welded directly to the existing frame walls. However, as is shown in FIGS. 7 and 8 additional plates are provided in the particular example illustrated. Thus, FIG. 7 shows part of the rear wall 38 welded by a bead 84 to an additional plate 86 which is in turn welded by a bead 88 to part of the belly guard 82. FIG. 8 shows part of a side wall 28 of the frame fixed by the weldment bead 90 to a plate 92 which is welded by a bead 94 to one of the inclined side walls 96 of the belly guard. This weld structure extends all along the double-lined regions 98 illustrated in FIG. 5, so as to achieve a watertight connection between the compo-
ments in this way. Where the belly guard has any substantial opening, an additional plate such as the plate 100 may be provided and connected all along its edge by the welding structure 98 of the type shown in FIGS. 7 or 8.

Thus, this structure of the existing frame plates and belly guard with the welded connections therebetween form an enclosure means for enclosing the engine and various additional components in a watertight manner. The enclosure means is designed so that a relatively large space for circulation of air around the engine will be assured. Within this space is located, in addition to the engine, various motors, compressors, pumps, etc., all of which may be driven by any suitable transmissions, such as belt and pulley transmissions, from the engine in a well known manner.

A plurality of removable closure plates are provided for giving access to the engine as required. Thus, FIG. 6 shows one such plate 102 connected to the bottom wall portion 104 of the belly guard. For this purpose the belly guard has welded thereto suitable bolts 106 which may carry nuts 108. Between the plate 102 and the exterior surface of the wall 104 is a suitable sealing ring or gasket 110. This structure is surrounded by a protective ring 112 welded to the exterior surface of plate 104 by a bead 114 and reinforced by suitable triangular plates 116. Thus, this structure formed by bolts 106, nuts 108, and sealing ring 110 provides a connecting means for removable connecting a cover plate 102 to the enclosure means in order to cover an opening thereof in a watertight manner while at the same time making it possible to have access to the interior of the enclosure when a plate such as the plate 102 is removed.

In the example illustrated in FIG. 5, three of the assemblies shown in FIG. 6 are connected to the bottom of the belly guard, the assembly 118 which is shown in FIG. 6, being provided for giving access, for example, to the radiator of the engine. A second assembly 120 of the same construction is provided to give access to the crankcase for changing the oil, while a third assembly 122 of the same construction is provided for giving access to the torque converter. In addition there is a side cover plate 124 connected in the same way by bolt-and-nut assemblies 126 and an unillustrated sealing ring, this structure being protected by structures such as the flange elements 128. This removable cover plate 124 can be removed in order to give access to pulley belts or other transmissions which may need servicing. In this way, while the components within the enclosure means are maintained watertight during submerged operations of the bulldozer, at the same time when the bulldozer is out of the water it is a simple matter to remove any of the cover plates so as to provide required servicing.

In addition, as a safety feature, the bulldozer is provided, in the manner shown schematically in FIG. 2, with an automatic pump assembly 130 having a suction pipe 132 which extends to the lowest part of the belly guard in the interior of the enclosure means, this pump assembly 130 having a discharge pipe 134. This unit 130 is of a well known type which automatically starts operating if any water should accumulate in the lowermost part of the belly guard where the lower open end of the pipe 132 is located, so that in this way if it should happen that unexpectedly water seeps into the enclosure it would immediately be pumped out.

Thus, a bulldozer having the construction described above and shown in the drawings is capable of operating very effectively in very substantial depths of water which may extend all the way up to the upper support means 12 so that it is possible to operate in depths of water as great as approximately twenty feet with the structure of the invention. At the same time it is also possible to carry on operations on dry land.

All of the liquid tanks, including not only the fuel tank, but also the tank for the oil or other hydraulic pressure liquid, are located above the elevation of the upper support means 12, carried thereby. The same is true of the air intake and exhaust pipes which protrude high into the air, as described above and shown in the drawings, so as to avoid the possibility of any accidental entry of water into the engine intake and exhaust. The turbo charger and generator which are situated above the engine may initially be protected with a special covering material. While the ripper limiter and hydraulic lines extend to the controls from the outside of the waterproof enclosure means, the brake control, gear control, and engine controls as well as all of the lines therefor, are enclosed within the waterproof enclosure means or housing of the invention. The side door or cover plate 124 is particularly useful, since when the latter is removed it is possible to inspect and adjust the engine as well as to change any belts and to change the fuel filter. The space within the enclosure means, particularly around the radiator of the engine, is made sufficiently great to provide for free flow of air around the radiator.

The front and rear attachments 40 and 58 can readily be removed so that the front and rear plates 34 and 38 can be used for pushing purposes, for example. It is thus clear that the bulldozer of the invention is capable of performing a wide variety of operations.

What is claimed is:

1. In a bulldozer, an engine and components coacting therewith for driving and operating the bulldozer, upper support means including a flat floor for supporting an operator at an upper portion of the bulldozer on said floor at an elevation higher than said engine and components, control means situated at the elevation of said support means on said floor accessible to the operator for controlling said engine and components to control the operation of the bulldozer, and watertight enclosure means connected to and extending downwardly from said floor of said upper support means and enclosing in a watertight manner a space beneath said floor in which said engine and components are located for maintaining said engine and components operative in depths of water which may approach up to said floor of said upper support means, said enclosure means including metal elements welded to each other for maintaining the enclosure means watertight at the locations where the metal elements are welded to each other, said enclosure means carrying at a lower portion thereof a plurality of closure plates through which access may be had to the interior of said enclosure means for giving access to the engine and components therein, and connecting means releasably connecting said closure plates to said enclosure means in a watertight manner, so that the tightness of the interior of said enclosure means is maintained at the removable closure plates, said engine including intake and exhaust pipes which extend through said floor to elevations higher than said support means so as to maintain the intake
and exhaust of the engine clear of any water in which the bulldozer operates, a blade operatively connected to the bulldozer at the exterior thereof for carrying out operations on submerged ground, and indicating means operatively connected with said blade for indicating to an operator on said upper support means the position of a submerged blade, an automatic pump means carried by said enclosure means for automatically pumping out of the interior thereof any water which may leak into said enclosure means, said enclosure means including a conventional frame and belly guard, and additional plates welded to said frame and guard for forming a watertight connection therebetween, liquid-holding tanks being carried by said upper support means on said floor thereof to protect the tanks against flooding, a front blade means and a rear ripper means operatively connected with said enclosure means, said front blade means having a configuration enabling the latter to operate also as a bucket means.