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European Patent Office
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(11) Publication number:

**0 205 341
A1**

(12)

EUROPEAN PATENT APPLICATION

(21) Application number: 86304433.5

(51) Int. Cl.⁴: **E 02 F 3/88**
E 02 F 5/00, E 02 F 9/06

(22) Date of filing: 10.06.86

(30) Priority: 10.06.85 GB 8514565

(43) Date of publication of application:
17.12.86 Bulletin 86/51

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

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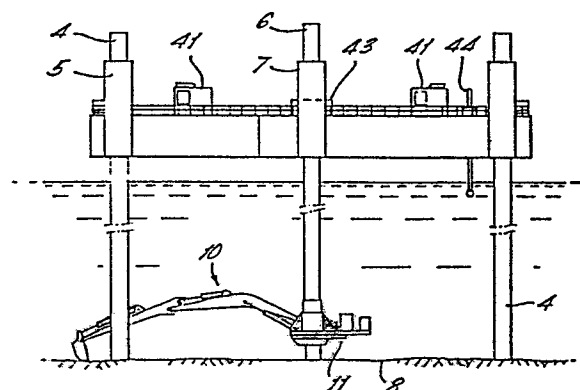
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(54) Underwater ground working apparatus.

(57) A platform is positioned at or above the water level with a leg extending downwardly into the water, and means (10) for working the ground are mounted on the leg with control means being provided either on the platform or arranged for underwater control by a diver. Cameras or other sensors (44) may be provided on the platform to monitor the underwater operation. The working means can be one of a number of devices such as a grab or drill on the end of a hydraulically powered articulated arm powered by a generator on the platform. The apparatus is useful in underwater digging, excavating, compacting and drilling and avoids the need for manual work by divers.

FIG. 2.



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UNDERWATER GROUND WORKING APPARATUS

10 This invention relates to underwater ground
working apparatus.

15 In underwater activities such as underwater
construction work, it is often necessary to carry out
various operations on the ground, for example,
digging, excavating, compacting and drilling.
Heretofore, it has been usual for divers to carry out
such work manually, if its nature is sufficiently
light, but this work has been severely limited by the
restricted capacity of what a diver can do manually
20 and because of the difficulty of moving in water,
particularly in greater depths. It has also been
known to use an ordinary bulldozer but this of course
can only operate in very shallow water owing to the
fact that some components of the bulldozer, such as
25 the exhaust pipe, must remain above water.

30 The invention accordingly provides underwater
ground working apparatus comprising a platform for
location generally above an underwater site at which
working is desired to be carried out, the platform
being positioned in use at or above water level, a
leg mounted on the platform and extending in use
generally downwardly therefrom into the water, means
mounted on the leg for working the ground generally
35 below the platform, and means for controlling

operation of the working means.

Preferably, the leg is arranged so that it can engage the ground in use thereby to stabilise the leg and the working means.

The working means may advantageously be mounted for movement generally up and down on the leg.

The leg may be mounted for generally vertical movement relative to the platform, the apparatus comprising means for raising and lowering the leg. Optionally, the leg may be mounted such that its orientation is angularly adjustable relative to the platform.

The apparatus preferably further comprises stabilising means mounted on the platform for engaging the ground whereby to stabilise the platform, and means for raising and lowering stabilising means relative to the platform. Typically, the stabilising means would be operable to support the platform above the water level.

It should be understood that the term "platform" is used in this specification in a general sense to include both buoyant vessels and non-buoyant structures which are supported on stilts extending down through the water to the ground.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic plan view of apparatus

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embodying the invention;

Figure 2 is a side elevation of the apparatus of figure 1;

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Figures 3, 4 and 5 are perspective views of different forms of leg or stilt for use in the apparatus of Figures 1 and 2;

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Figure 6 is an enlarged elevation showing the ground working means of the apparatus of figure 1;

Figure 7 is a sectional plan of part of the means of figure 6;

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Figure 8 is a sectional plan of a modified ground working means used in conjunction with a leg of rectangular cross section,

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Figure 9 is an elevation showing the ground working means of Figure 8, and

Figures 10 to 15 are elevations showing various modifications of the apparatus.

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Underwater ground working apparatus generally indicated 1 comprises a platform in the form of a buoyant pontoon 2 which is formed by several buoyancy compartments 3 secured together. This sectional construction allows for ease of transport by ship or overland. Secured to the compartments 3 are four sleeves 5 in each of which is mounted a respective stilt 4 for engagement with the sea bed 8. The stilts 4 may be of circular or rectangular cross section as shown in Figures 3, 4 and 5 and in Figures

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1 and 2 are shown as circular. The sleeves 5 provide for the stilts 4 to ascend and descend relative to the pontoon 2 and there is an appropriate mechanical interengagement (such as rack and pinion) between the stilts 4 and their respective sleeves 5 for raising and lowering the stilts 4 relative to the pontoon 2. The stilts 4 shown in Figures 3 and 5 have teeth 17 whilst in Figure 4 the stilt is provided with indentations 18 so that in each case the stilt 4 may act as a rack co-operating with a suitable pinion (not shown) within the sleeve 5. Power for raising and lowering the stilts 4 is provided by power units 41 and each stilt can be controlled independently. Reference numeral 44 refers to a profiler machine which runs on rails 42 mounted on the pontoon 2, the function of the profiler machine being to provide imaging of the underwater activities for viewing on deck. The machine may incorporate sensors such as television cameras, echo-sounders or lasers for obtaining measurements of the profile of the sea bed and may incorporate computer control.

Secured to one of the compartments 3 is a sleeve 7 in which is adjustably mounted a leg 6 similar to the mounting of stilts 4 in sleeves 5 and may similarly be of circular or rectangular section and forming a rack as in Figures 3, 4 and 5. The sleeve 7 provides for vertical movement of the leg 6 relative to the pontoon 2 and there is again a mechanical drive connection between the sleeve 7 and leg 6 to raise and lower the leg. As can be seen from figure 2, the leg 6 can engage the ground 8 in use to provide stability for the leg and for working means 10 which is mounted on the leg. Operation of the working means 10 is controlled from an operation

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and can also be raised and lowered to a limited extent on the leg 6 by means of hydraulic rams 12 each attached at one end to the turntable 11 and at the other end to a base plate 13 which rests on the sea bed 8. Hydraulic motors 14 provide for rotation of the turntable 11 about the leg 6 by means of a drive mechanism 15 incorporating gearing, chain and sprockets or the like. A boom 20 is pivoted to the turntable 11 and can be raised and lowered by means of a pair of hydraulic rams 21. An arm 22 is pivoted in turn to the boom 20 and is movable relative thereto by a hydraulic ram 23. Pincers 24 are pivoted to the arm 22, operation of the pincers being by respective hydraulic rams 25 each pivoted at one end to a pincer 24 and pivoted at the other end to a respective trunnion 26 secured to the arm 22. The pincers 24 are shown in a closed position in solid lines in figure 6, ghost lines showing the pincers open. Reference numeral 28 refers to a hydraulic control unit for the supply of hydraulic fluid to the motors 14 and rams 12, 21, 23 and 25. Reference numeral 29 designates a counterweight mounted on the turntable 11. In order to lock the turntable 11 relative to the leg 6, means in the form of hydraulic cylinders 30 are mounted on the turntable 11 to operate locking bolts 31.

Figures 8 and 9 show an alternative arrangement in which the leg 6 is of rectangular cross section. In Figure 9 the working means 10 is shown in various stages of lifting objects.

Figure 10 shows an alternative working means 10 in the form of a mechanical grab which is pivoted to the turntable 11 in place of the pincer assembly

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20-26. The grab assembly comprises a bracket 33 pivoted to the turntable 11, a hydraulic ram 34 being connected therebetween. A first parallel pair of arms 35 is pivoted to the bracket 33 at one end and to both a link 36 and a second pair of parallel arms 37 at the other end. The second pair of arms 37 are pivoted to a link 38 to which is secured one of a pair of grab members 39, 39'. The other grab member 39' is pivoted to the link 38 and is movable relative to the first grab member 39 by means of a hydraulic ram 40. Movement of the linkage 35-40 relative to the bracket 33 is achieved by virtue of a hydraulic ram 32 pivoted at its opposite end to the bracket 33 and the upper arm 35. The grab assembly 10' is shown in different positions in ghost lines in figure 10.

In use, the pontoon with the stilts 4 and leg 6 raised is floated out on the water to a position generally above the underwater site at which work is to be carried out. The stilts 4 and leg 6 are then lowered so as to engage the ground and their movement relative to the pontoon 2 is continued so that the pontoon is raised bodily out of the water as shown in figure 2. In this position, it will be appreciated that the effect of waves and tide is considerably less on the apparatus than with the pontoon in the water.

Figure 11 shows a variation in which the leg 6 is mounted such that its orientation is angularly adjustable relative to the pontoon 2. This is achieved by means of a pivotal connection between the sleeve 7 and the pontoon 2. Reference numeral 46 designates flexible hydraulic hoses connecting the control unit 28 and the operation compartment 43.

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The working means shown in figure 11 is similar to that of figures 1,2,6,7,8 and 9 except that a scoop 50 is provided pivoted to the arm 22 in place of the pincers 24 and is operated by a single hydraulic ram 25. As will be appreciated, the angular adjustability of the leg 6 increases the versatility of the apparatus, allowing it to be used for example for the grading of a slope 51.

10 In Figure 12, the pincer assembly 10 is being used for building up piles of boulders 52, for example, in the construction of a breakwater. Operation of the leg 6 and pincer assembly 10 are in this instance being operated remotely by a diver 53
15 by means of a control box 54 connected to the control compartment 43 by a flexible control line 55. This is an alternative to controlling the leg and assembly 10 from the control location 43 itself and viewing the action of the pincers by a closed circuit
20 television arrangement using a television camera underwater mounted, for example, on the leg 6 or one of the stilts 4.

25 In figure 13, the apparatus has been used in the construction of a pipeline under the sea bed. Using a modified working means 10" which has grab members 57 in place of the pincers 24, operation is as follows. Firstly, a trench 60 is dug, the dredged sand or other material 61 being placed on one side. A
30 bedding layer of sand 62 is then compacted into the base of the trench 60 and on this the pipes 63 are laid. Some of the material 61 is then placed into the trench at 64 and 65 followed by a layer of stones 66. Finally, a layer of the dredged material 61 is
35 compacted on top of the stones 66 at 67. For the

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purposes of compaction, the grab members 57 are closed together or alternatively a separate compacting tool may be used mounted on the turntable 11.

In figure 14, a modified turntable 11" has two forms of working means mounted thereon. On the right hand side is a scoop assembly like that in figure 6 while on the left hand side a rock breaker 56 is pivoted to the arm 22 in place of the scoop 50. when dredging, it is not uncommon for hard layers of rock to be encountered and these need a rock breaker to be dealt with. By providing for two working means in this way, two areas can be worked simultaneously and/or dual function provided by one turntable. The right hand working means is additionally provided with an injector pump 58 to suck up material loosened by the scoop 50. The dredged material passes through a flexible hose 59 connected to the pump 58 and is discharged into a barge 70.

In figure 15 a drilling assembly 72 is pivoted to the turntable 11. This assembly comprises an arm 73 pivoted to the turntable 11 and moved relative thereto by a hydraulic ram 74. A hydraulic motor 75 is pivoted to the outer end of the arm 73 and its orientation relative thereto is adjusted by a hydraulic ram 76. The motor drives a drill 77 to form holes 78 in the ground and into which piles 79 may be driven by a hydraulic vibration hammer (not shown) which may be attached to the arm 73.

It will be apparent that the above described apparatus can be used for a very large variety of purposes and has the great advantage that, because

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the working means is fully submerged during operation, it is not susceptible to adverse surface conditions such as bad weather and waves. It also has the advantage of eliminating the danger of injury to a diver working underwater or, in the case of underwater control by a diver, reducing such danger to a minimum.

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CLAIMS

1. Underwater ground working apparatus characterised by comprising a platform for location
5 generally above an underwater site at which working is desired to be carried out, the platform being positioned in use at or above water level, a leg mounted on the platform and extending in use generally downwardly therefrom into the water, means
10 mounted on the leg for working the ground generally below the platform, and means for controlling operation of the working means.

2. Apparatus as claimed in claim 1
15 characterised in that the leg is arranged so that it can engage the ground in use thereby to stabilise the leg and the working means.

3. Apparatus as claimed in either preceding
20 claim characterised in that the working means is mounted for movement generally up and down on the leg.

4. Apparatus as claimed in any preceding
25 claim characterised in that the leg is mounted for generally vertical movement relative to the platform, the apparatus comprising means for raising and lowering the leg.

5. Apparatus as claimed in any preceding
30 claim characterised in that the leg is mounted such that its orientation is angularly adjustable relative to the platform.

6. Apparatus as claimed in any preceding
35 claim characterised by further comprising stabilising means mounted on the platform for engaging the ground

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whereby to stabilise the platform, and means for raising and lowering the stabilising means relative to the platform.

5 7. Apparatus as claimed in claim 6 characterised in that the stabilising means is operable to support the platform above the water level.

10 8. Apparatus as claimed in any preceding claim characterised in that the control means is operable from a location on the platform.

15 9. Apparatus as claimed in any preceding claim characterised in that the control means is operable from an underwater location.

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FIG. 1.

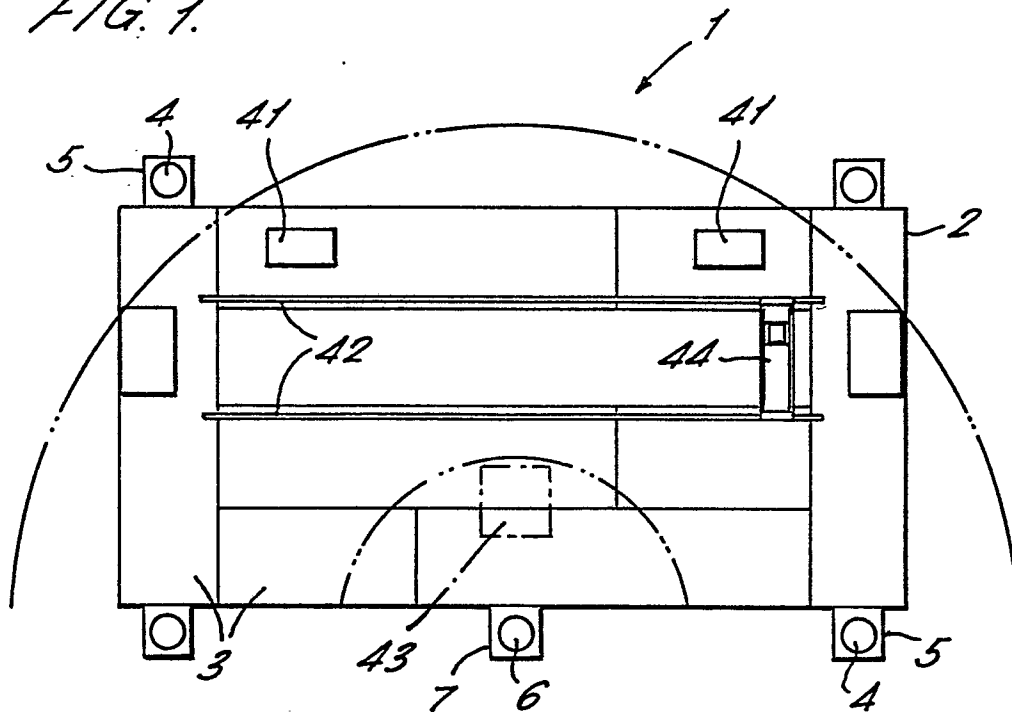
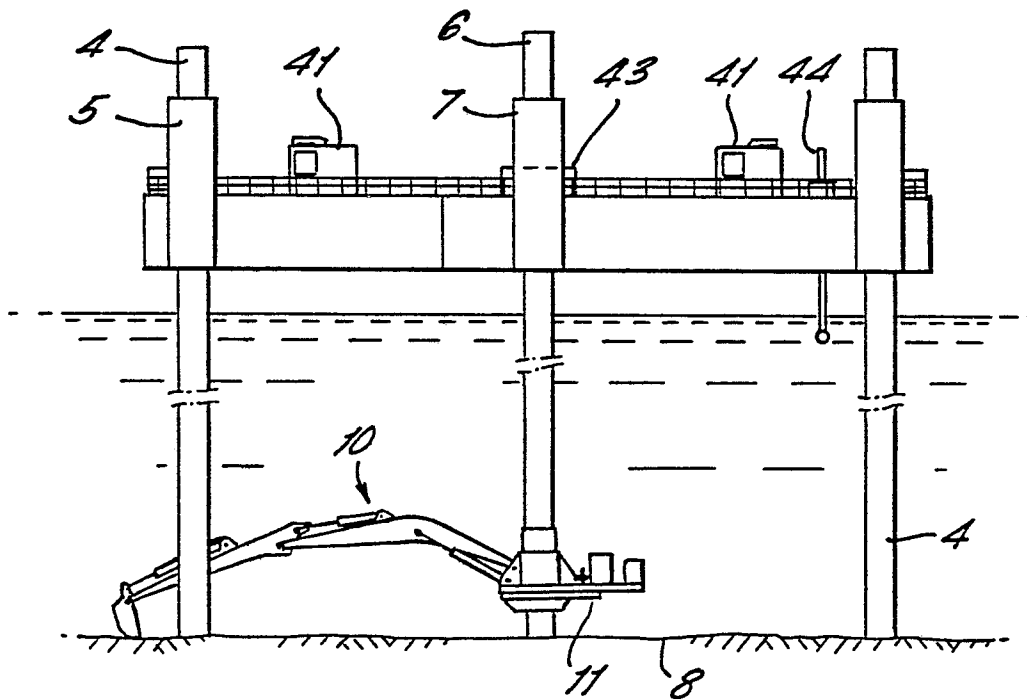


FIG. 2.



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FIG. 3.

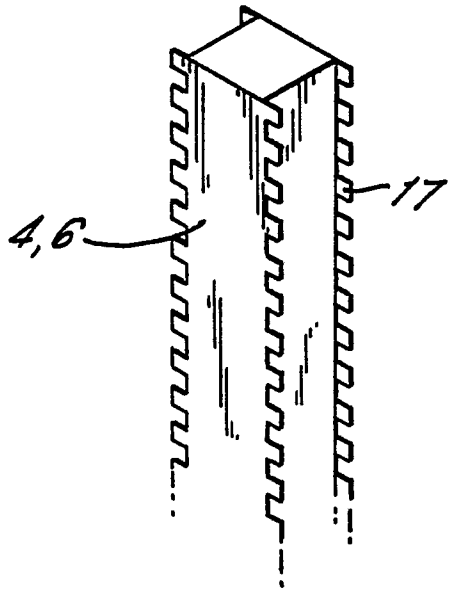


FIG. 4.

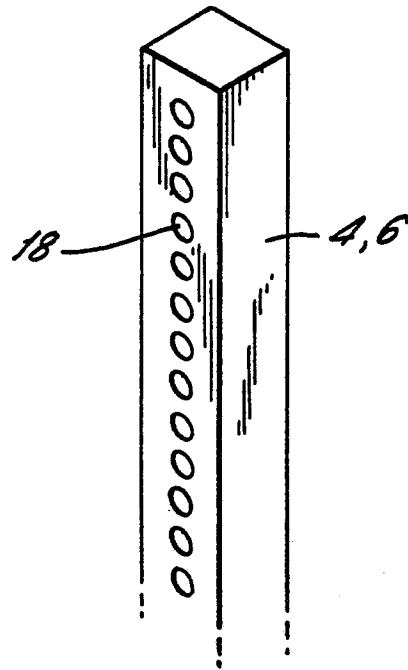
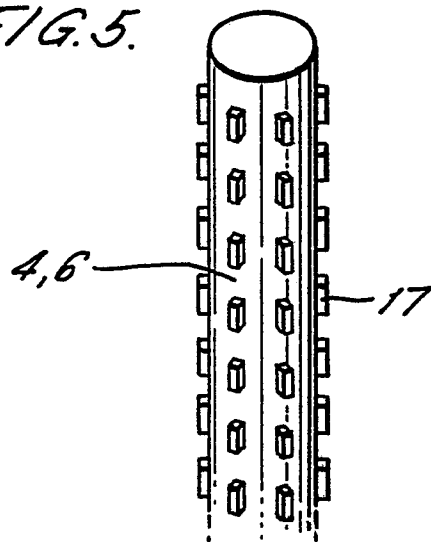


FIG. 5.



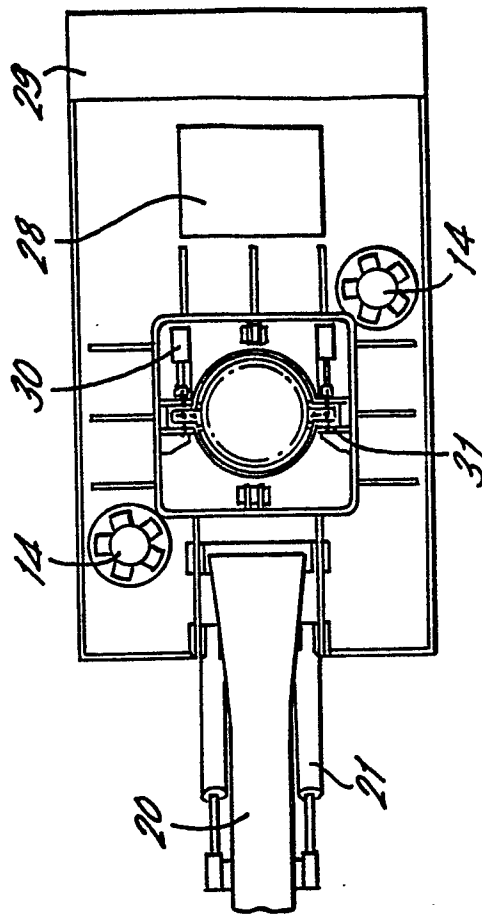
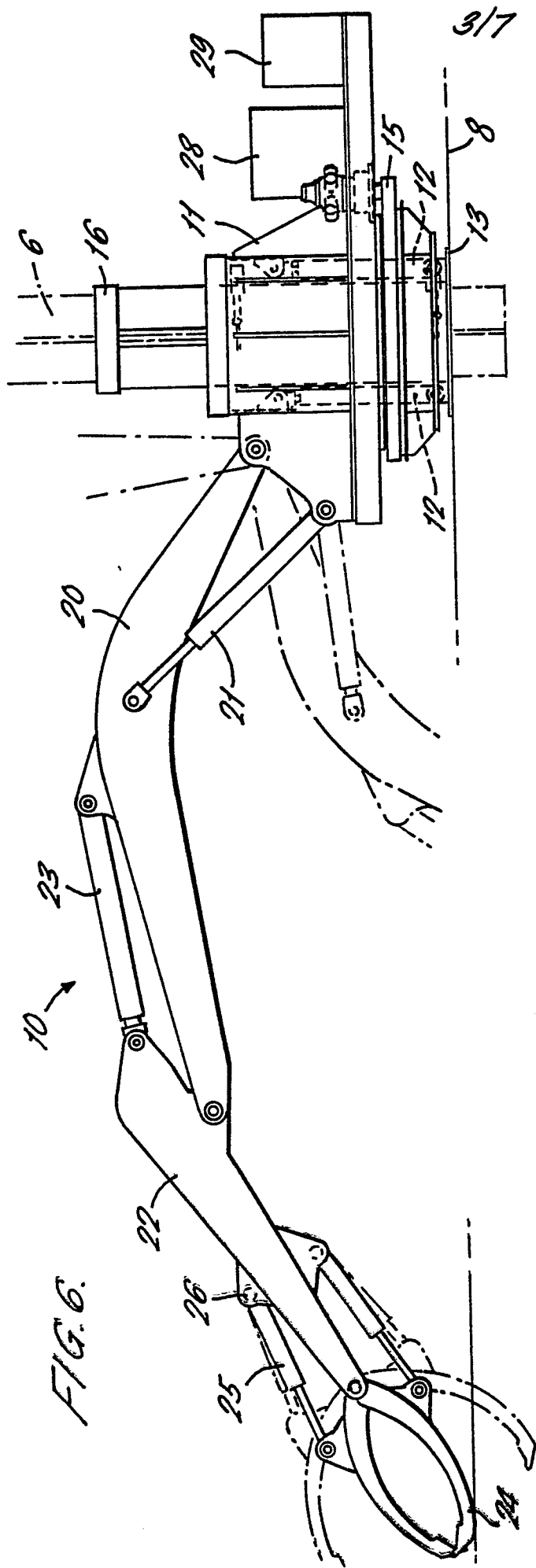


FIG. 7

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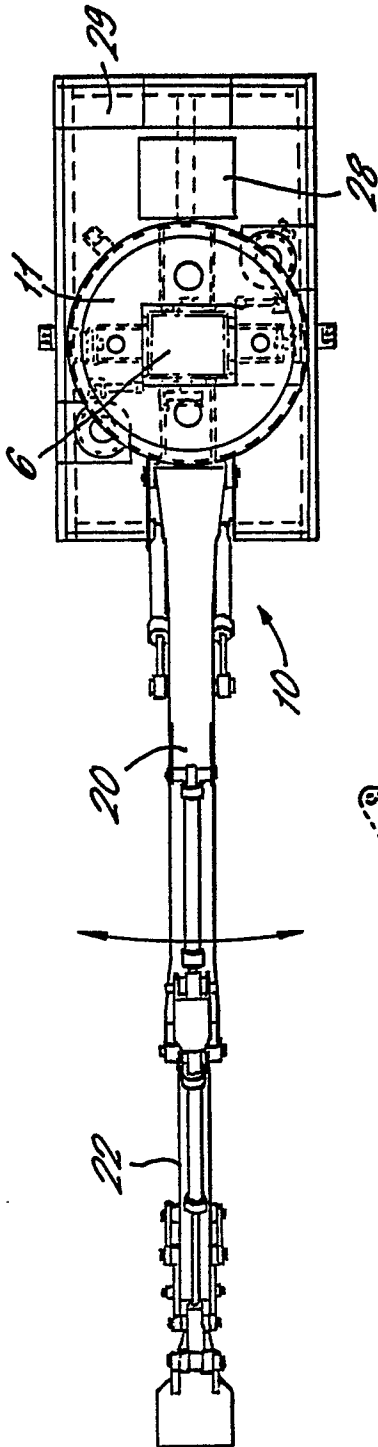


FIG. 8.

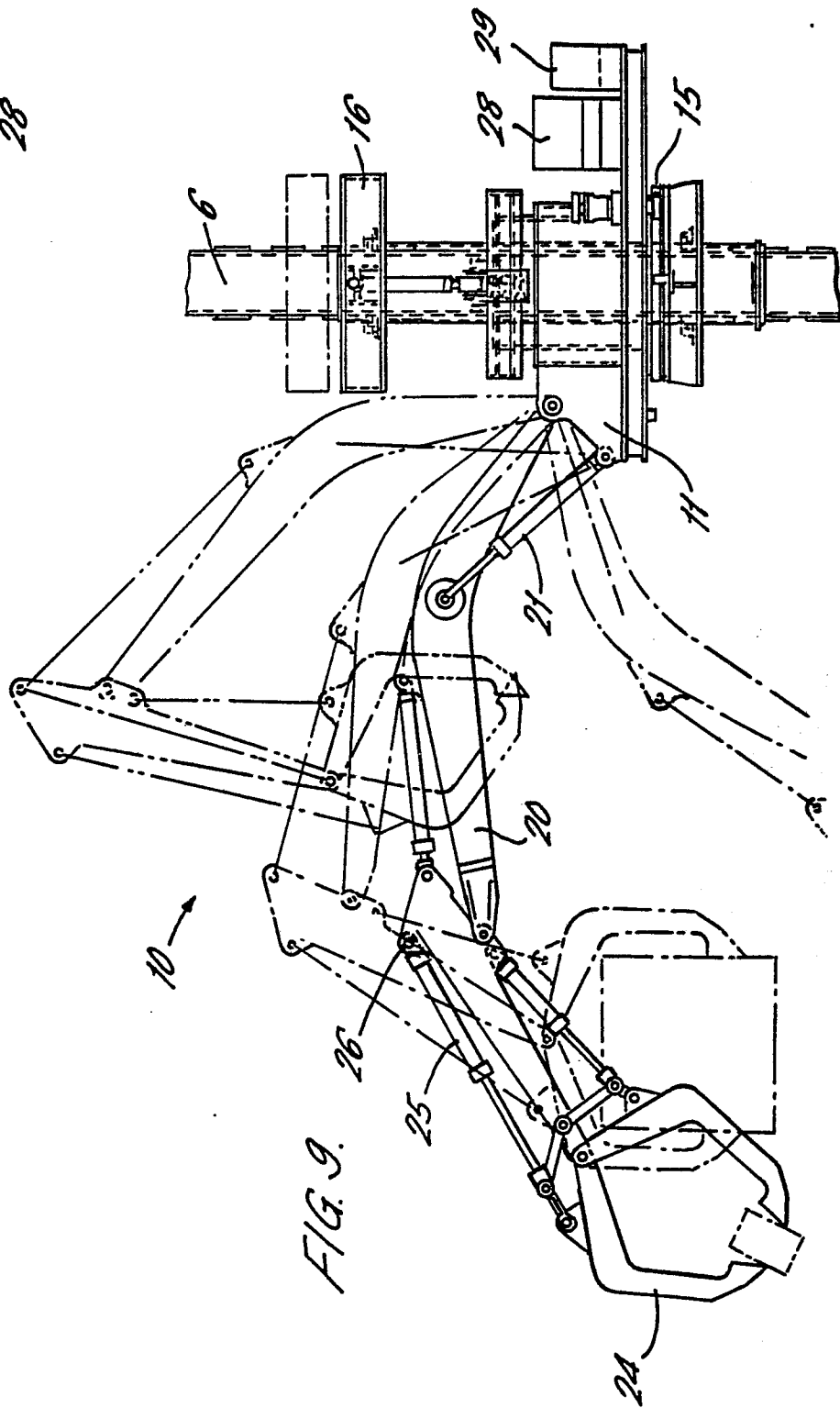


FIG. 9.

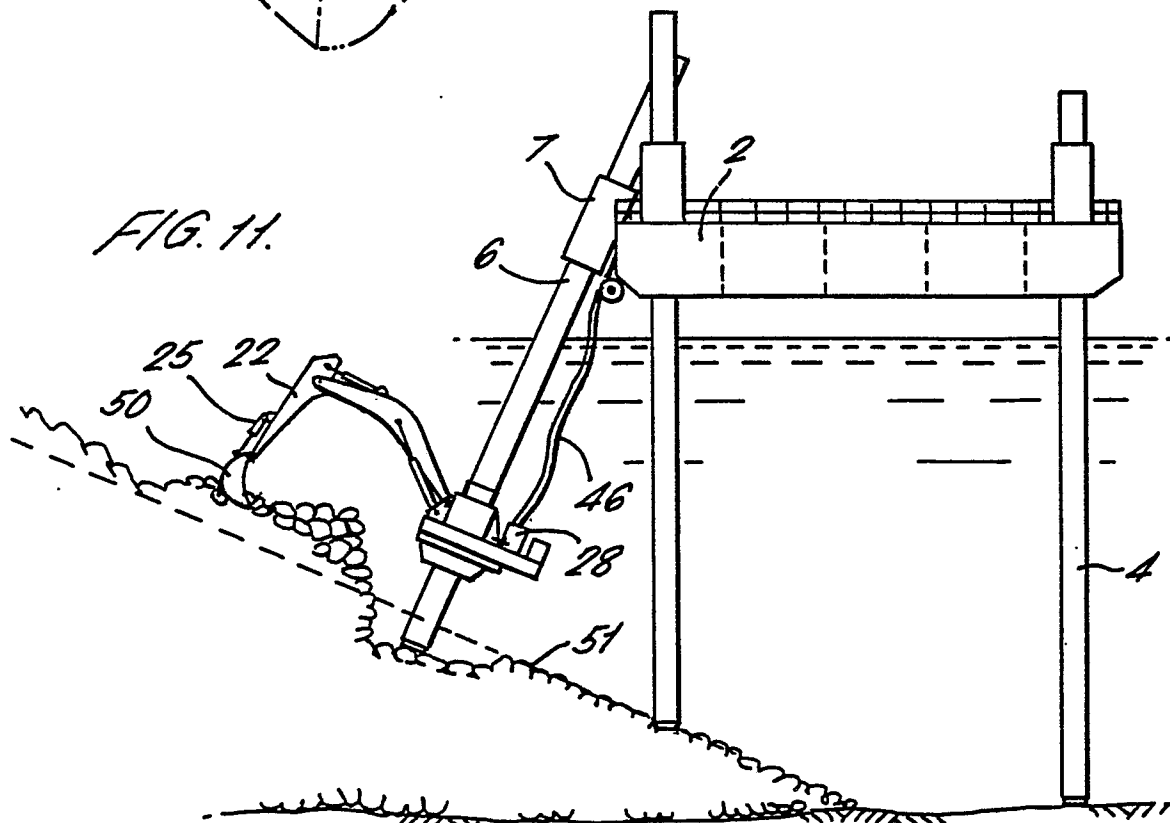
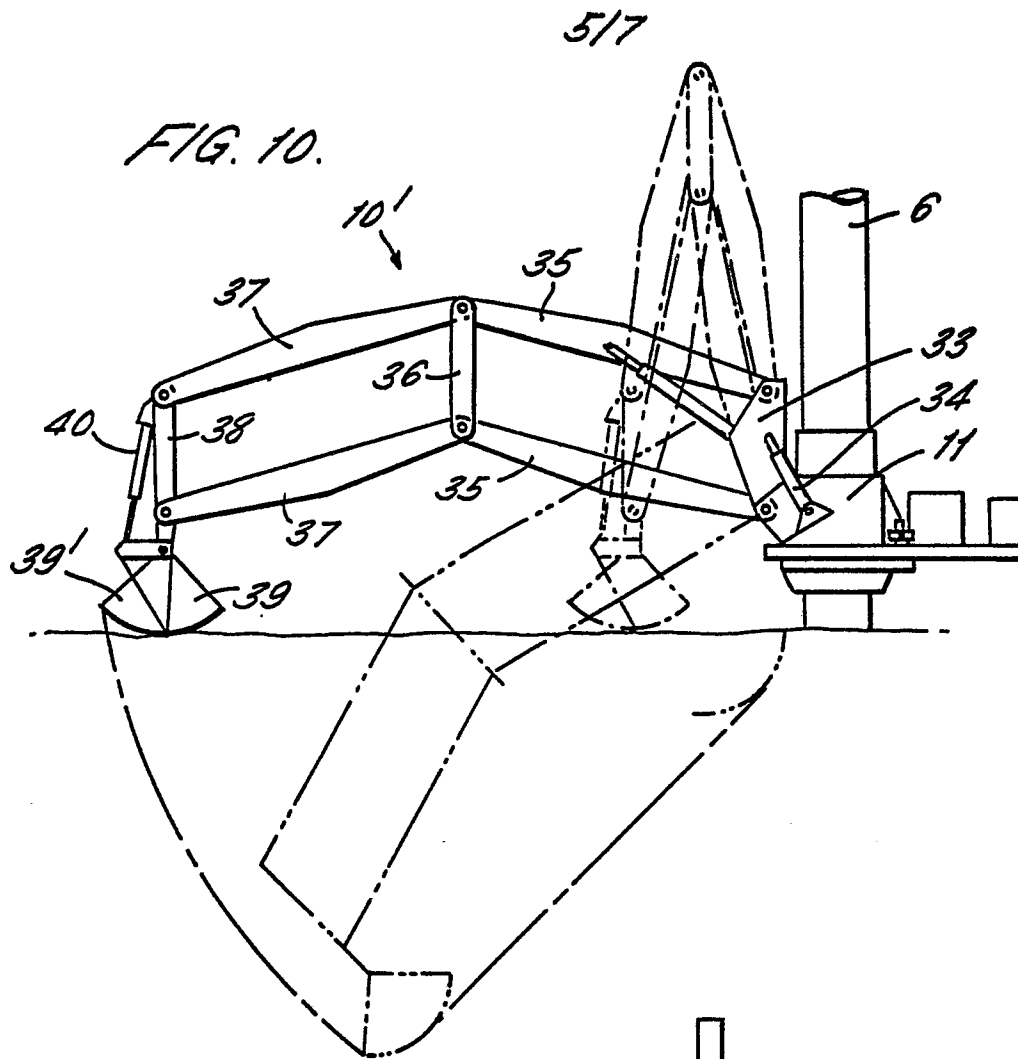


FIG. 12.

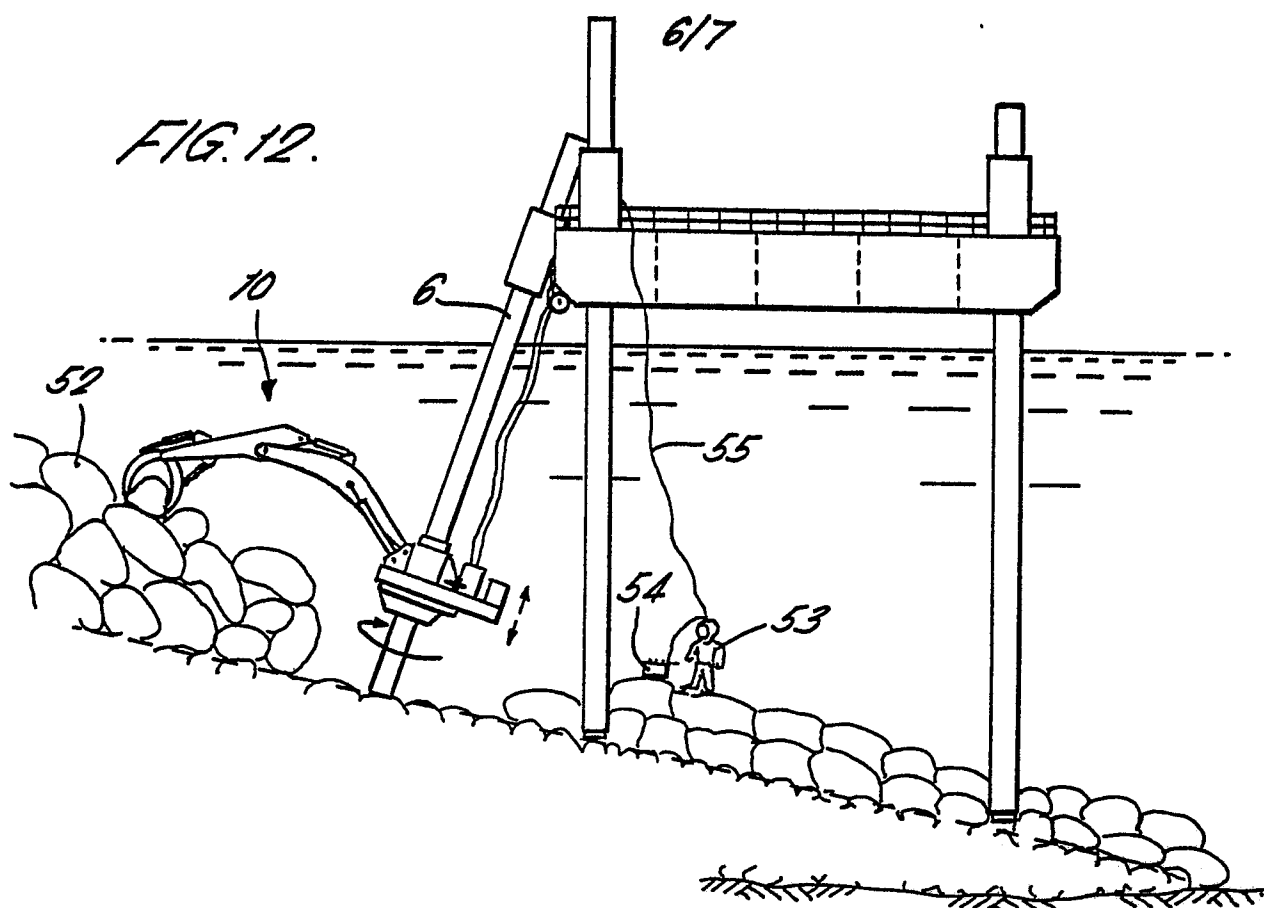
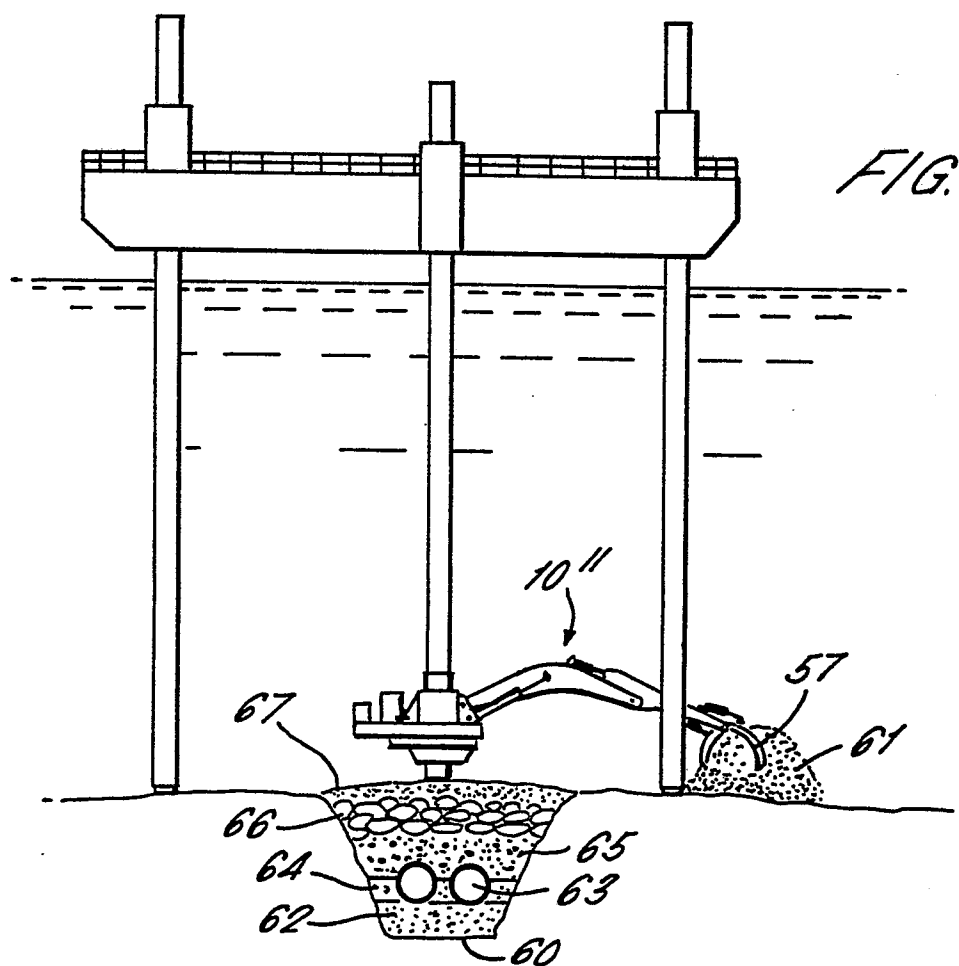
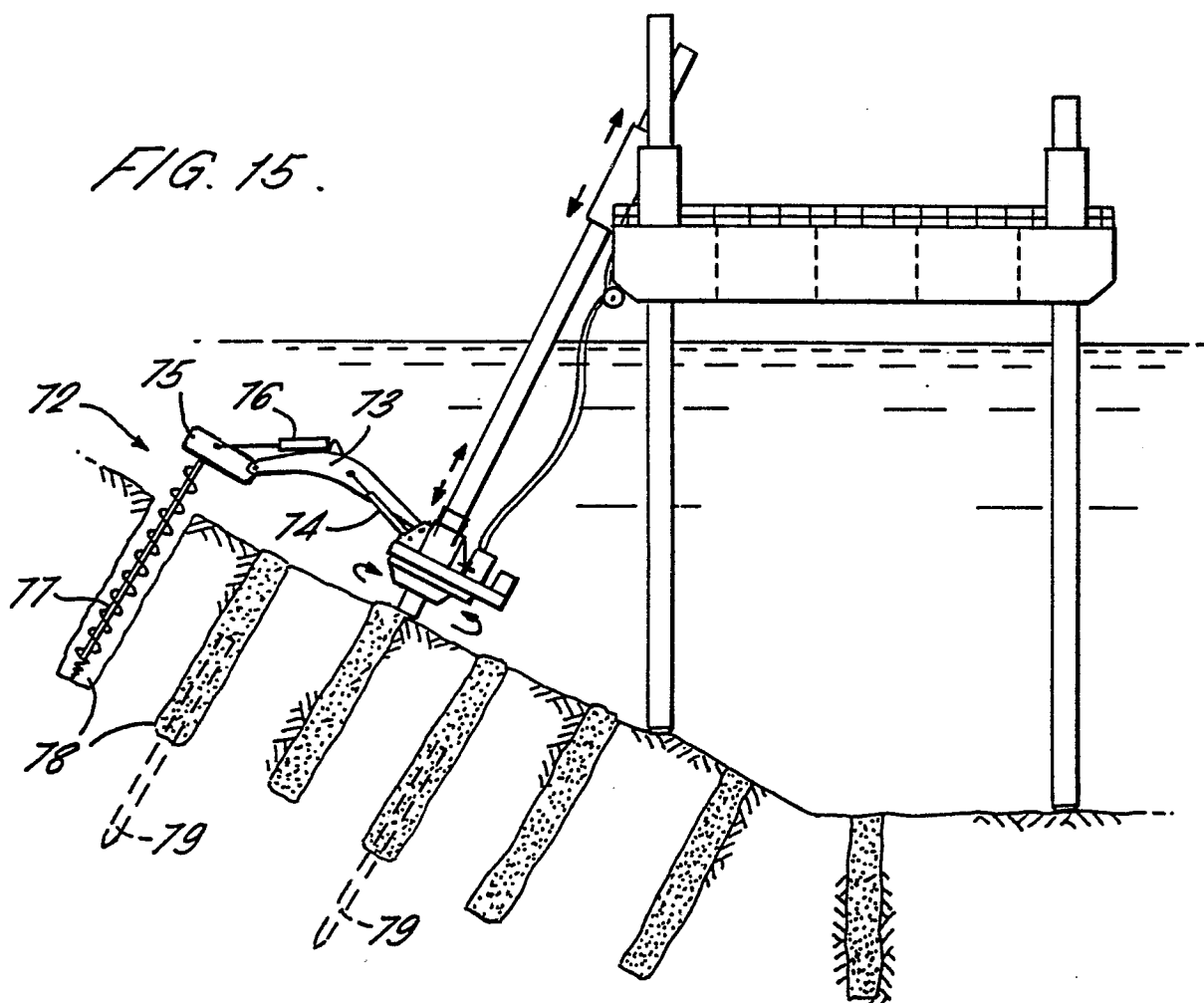
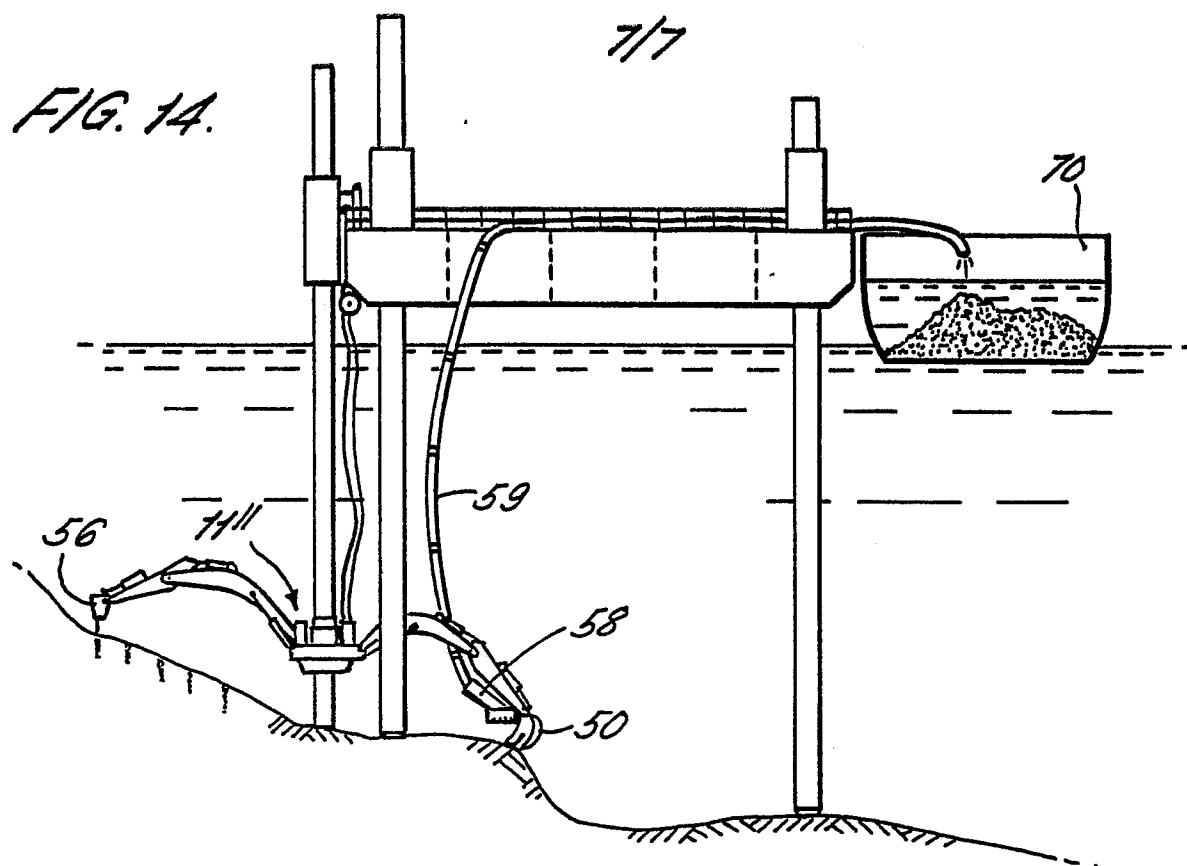


FIG. 13.







European Patent
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EUROPEAN SEARCH REPORT

0205341

Application number

EP 86 30 4433

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	FR-A-1 388 757 (DE LONG CORP.) * Whole document *	1-4, 6-8	E 02 F 3/88 E 02 F 5/00 E 02 F 9/06
X	FR-A-2 383 273 (BALLAST-NEDAM GROEP N.V. et al.) * Whole document *	1-8	
X	US-A-3 218 739 (C.P. KAUFMANN et al.) * Whole document *	1-8	
A	US-A-3 629 963 (YASUO ITAMI) * Abstract; figure 1 *	1, 9	
A	GB-A-2 065 751 (I.A. KNIGHTS) * Abstract; figures *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	DE-A-1 484 718 (R.D. WEST) * Figure 1 *	1	E 02 F
A	US-A-2 092 011 (H.A. MUSHAM) * Figures 1-5 *	1	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 11-09-1986	Examiner ANGIUS P.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			