United States Patent [19]

Stevens

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[54] **PILE DRIVING METHOD**

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[52] **U.S. Cl.**..... **61/53.5,** 114/206, 175/20

[51] **Int. Cl.**..... **E02d 7/18,** B63b 21/26

[58] **Field of Search**..... 61/53.5, 53, 63, 52, 53.74; 114/206, 207; 175/20, 405

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[57] **ABSTRACT**

A method for driving tubular piling into ground beneath water in which the end of the piling is sealed against the ground and a vacuum is applied in the upper end of the piling to draw the piling downward and to draw a portion of the ground into the piling. Thereafter, the piston effect may be used to adjust the level of the piling.

8 Claims, 7 Drawing Figures

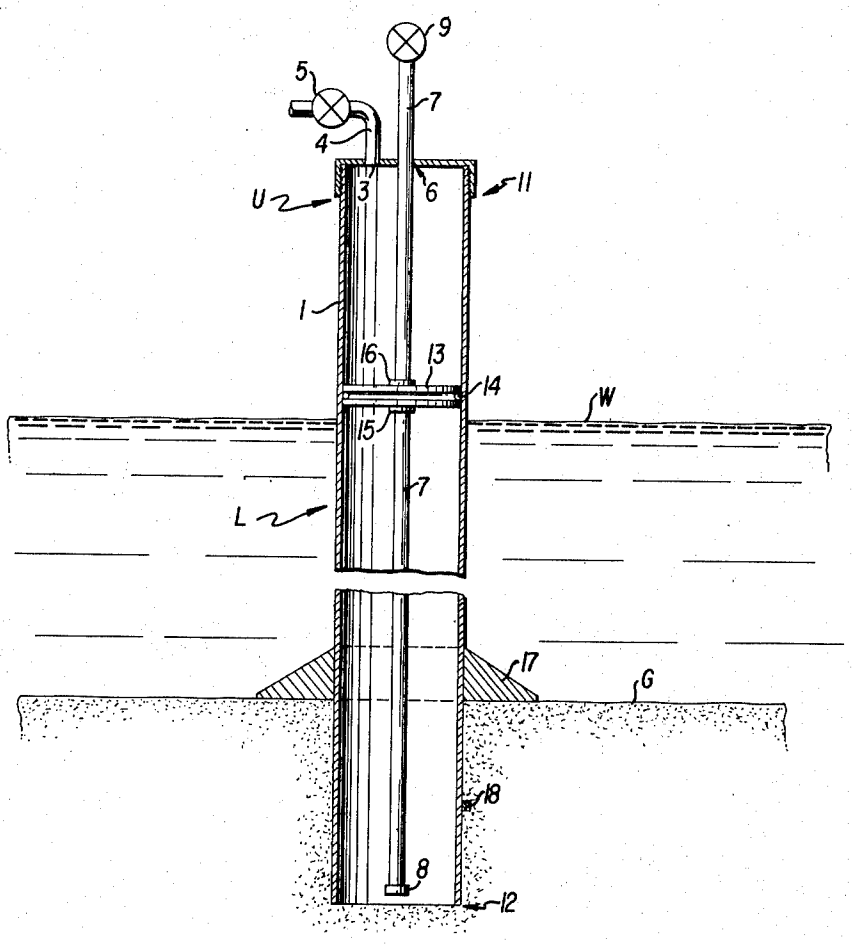


FIG. 1

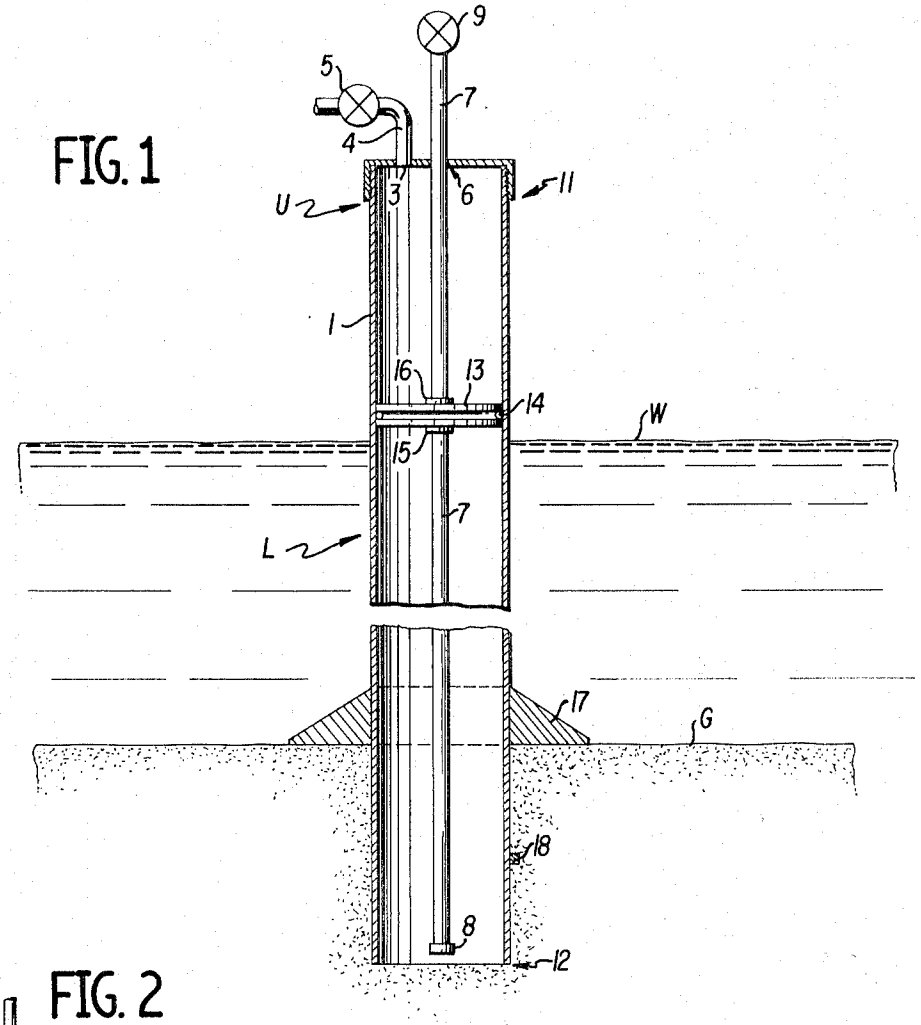


FIG. 2

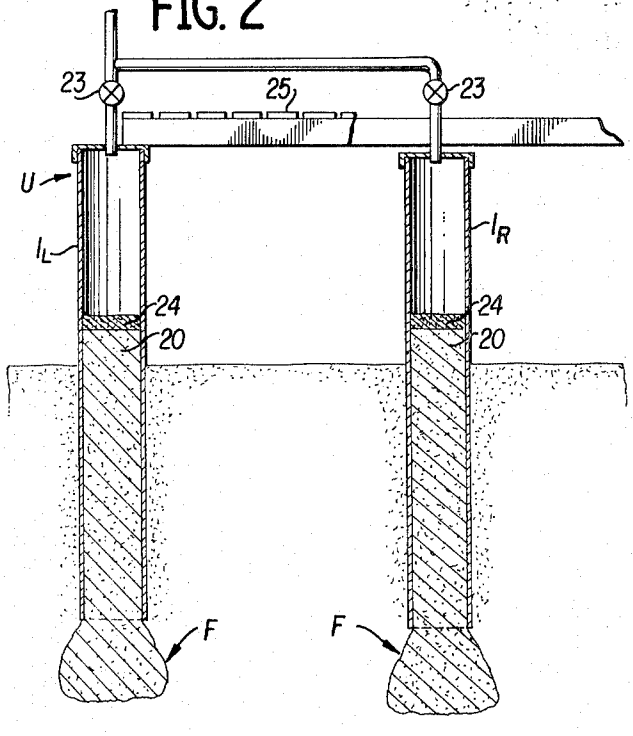
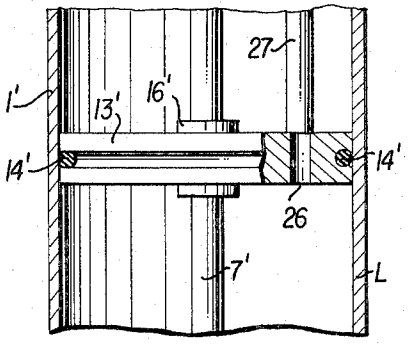


FIG. 3



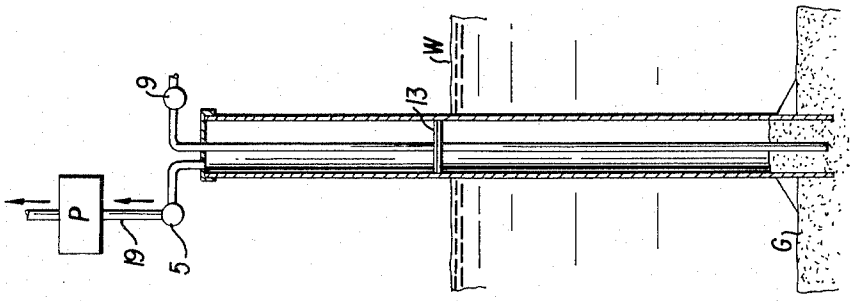


FIG.1d

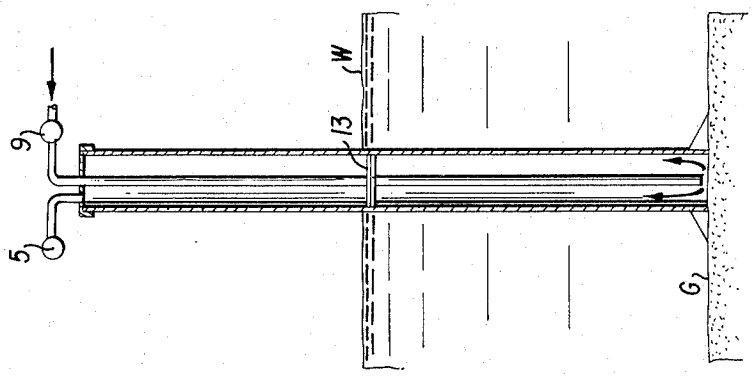


FIG.1c

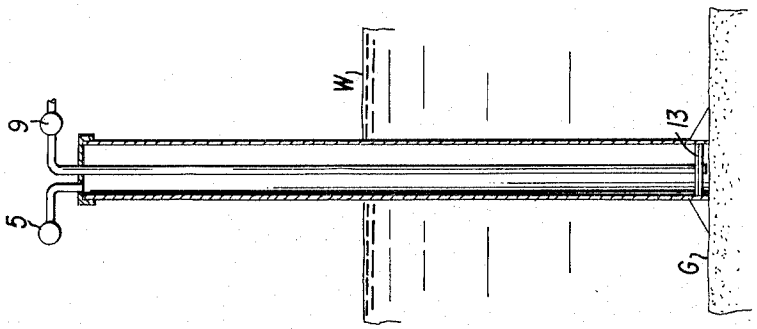


FIG.1b

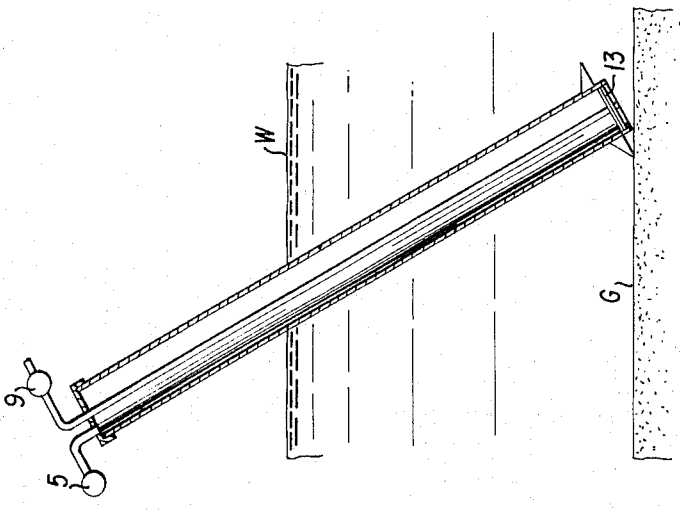


FIG.1a

PILE DRIVING METHOD

BACKGROUND OF THE INVENTION

The present invention relates to the driving and setting of pilings and is more particularly concerned with the driving, adjusting and setting of tubular pilings.

BRIEF DESCRIPTION OF THE PRIOR ART

Prior systems for driving tubular pilings have included impact-driving, either by direct impacting on the piling or by means of driving heads, with or without hydraulic agitation of the ground into which the piling is to be driven.

However, none of the prior systems has been found entirely satisfactory.

The prior systems have been found particularly deficient in the driving of relatively small pilings such as those used in setting up walkways in shallow water or small boat piers in narrow creeks or guts. The prior units are too cumbersome to enter such areas or are prone to run aground in the shallows. In tidal waters they are able to move and operate only on the flood. Most of such work necessarily has been done by hand driving.

SUMMARY OF THE INVENTION

In contrast, the present invention provides an extremely simple driving system which provides an exceptional versatility in setting and rigging pilings and piling sets.

In general, the preferred method of the present invention comprises sealing the tubular piling against the ground into which it is to be driven, filling a confined volume of the piling with water and evacuating a portion of said piling to cause the piling to be drawn into the ground and a portion of the ground to be drawn up within the piling.

Preferably, a piston member is provided in the piling to provide two chambers therein, the upper of which is to be evacuated.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the invention may be derived from the following description and the accompanying drawings in which:

FIG. **1** is a sectional view of a preferred form of the invention:

FIGS. **1A** through **1D** are partly schematic views showing the preferred method of driving the pilings;

FIG. **2** is a sectional view showing the preferred method for adjusting and levelling, multiple-piling sets, and

FIG. **3** is an enlarged view similar to FIG. **1** showing a modified form of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawings, a tubular steel piling **1** is closed, at one end, by a head **2.** The head **2** preferably is removable such as by a threaded connection, but may be permanently affixed to the piling if desired.

The head **2** has a fluid or drive aperture **3** which communicates with drive piping **4** which includes valve **5.**

The head **2** also carries a centrally-located aperature **6** through which a jet pipe **7** extends to the interior of the piling. The jet pipe **7** terminates in a nozzle **8** just inwardly of the end of the piling. The jet pipe **7** may be secured to the head either rigidly, as shown, or it may be adjustably secured by means of a suitable packing gland. At its upper end, the pipe **7** carries a valve **9.**

Intermediate the upper end **11** and the lower end **12,** a piston **13** engages the inner wall of the piling by means of a seal **14,** and receives and seals against the jet pipe **7** by means of a gland **16** surrounding a central aperture **15** therein.

A slideable collar **17** preferably is slideably installed on the outer surface of the piling to serve as an interference seal between the ground G and the lower end **12** of the piling. An abutment **18** is provided to limit the downward motion of the collar when the piling is in an upright position.

METHOD AND OPERATION FIGS. 1 THROUGH 1D

As best seen in FIG. **1A** and FIG. **1B**, the assembled piling is placed in position under water level W at the spot on the ground into which it is to be driven. In intermediate positions, such as shown in FIG. **1A**, the nozzle **8** acts as a keeper for the piston **13,** while the abutment **18** retains the collar **17.** Initially, the valve **5** is closed and the piston **13** is positioned adjacent the lower end to help avoid inclusion of air in the lower chamber L between the piston and the lower end of the piling. The desirability of air exclusion will be discussed more fully hereinafter.

After placement (FIG. **1B**) the valve **5** is opened and a high-pressure jet of water is directed through the valve **9,** jet-pipe **7** and nozzle **8** against the ground underlying the piling as represented in FIG. **1C.** The water stream loosens, agitates and suspends a portion of the ground in the liquid column formed in the lower chamber between the lower end **12** and the piston **13.** With the upper chamber U vented via valve **5,** the piston is free to be lifted upwardly by the increasing liquid column.

When the piston **13** has been moved a preselected distance, as may be measured by the volume of water supplied via the nozzle **8,** the jet stream through the nozzle is stopped with the valve **9** closed.

The upper chamber U is then quickly evacuated, through the piping **4** and the valve **5,** by means of a suitable exhausting pump P, via an articulated or flexible line **19,** (FIG. **1C**).

Since, in the absence of a substantial amount of air, the water column below the piston cannot expand to accomodate the lowering pressure in the upper chamber U, two complementary displacements are produced.

The piling **1** is drawn down into the ground, in reaction to the low pressure in the upper chamber, while a portion of the ground underlying the piling is drawn upwardly therein, the net result being that of driving the piling downwardly into the ground.

METHOD AND OPERATION, FIG. 2

When a series or set of pilings have been driven, my invention exhibits a particularly advantageous versatility, in that the stability of the piling/ground combination can be augmented and, at the same time, the levels of the several pilings can be adjusted.

As shown in FIG. **2,** the driven pilings **1L** and **1R** have had their piston **13** and jet-pipe **7** removed.

Each piling then receives a predetermined amount of loose solids, preferably clay **20.** The pilings are fitted with heads **22** carrying loading valves **23.** I prefer to employ loading valves of a size adequate for introducing the clay, but it is to be understood that the stabilizing clay may be introduced by removal of the heads **22.**

A piston is then provided at the top of each clay column. The piston may be an imperforate disc similar to the disc of FIG. **1.** However, I prefer to use a capping layer of granular, dense solids such as the piston layer **24** of FIG. **2.** Loose solids such as iron filings, barytes or sand — preferably in a petroleum-oil suspension to minimize mixing with the clay column — are introduced above the clay to form the plug layer or piston layer **24.**

Air pressure is then applied via valve **23,** forcing the piston downwardly to compact the clay. This is particularly advantageous in cases in which stable ground cannot be reached, such as in deep, loose sand. By this method, I am able to force stabilizing clay down out of the piling to form a compacted-clay footing F in the relatively loose sand.

When solid footings F have been established, levelling and finish-setting of the pilings is accomplished in a very simple method similar to the setting of the footings F. With the structural load imposed upon the pilings, such as the pier **25,** the weight of the load is not effective upon the piling **1R,** since it is below the desired level. Air pressure is applied through the valves **23** of both pilings **1L** and **1R,** simultaneously. The weight of the pier **25** will prevent motion of the piling **1L,** but the piling **1R** will be raised, by sufficient pressure, until that piling engages the pier and both pilings carry the load.

Therefore, the pilings are adjusted in level, to provide final setting of the pilings and their superimposed structure. Raising of the lower piling does not require resetting of its footing F, however, since the pressure used to lift the piling is simultaneously effective on the piston zone **24** and the clay **20** to maintain the compaction of the footing F.

DETAILED DESCRIPTION OF FIG. 3

A modified form of the invention is shown in this drawing which includes a piston **13** and other elements in common with FIG. **1** and having the same numerals, primed, as in that figure.

However, the piston **13** is provided with an additional aperture **26** extending therethrough to communicate with the lower chamber L below the piston. The aperture **26** is fitted with a conduit **27** extending upwardly therefrom which communicate with the exterior of the piling, preferably through the head (not shown).

METHOD AND OPERATION OF FIG. 3

The invention of FIG. **3** is particularly advantageous in services where it is desired to remove a portion of the water and the suspended solids below the piston **13.** The chamber L is evacuated such as by pump P via the aperture **26** and the conduit **27** to any suitable place of disposal. The piston **13** is thus lowered, with the valve **5** open (not shown) to the position desired or to the extent necessary to remove all the undesireables from the lower chamber.

Thereafter, the piston may be employed for further driving of the piling to a lower depth. Also, the piston may be removed and a desireable material introduced, such as the clay column **20.**

In this manner, undesireables such as muck or slime may be removed from the work area beneath the piling in order to reach more solid "ground" or to make room for a greater amount of clay when working in a loose sand environment.

Various changes may be made in the details of the invention as disclosed without sacrificing the advantages thereof or departing from the scope of the appended claims.

I claim:

1. A method for driving tubular piling into ground beneath overlying water comprising

a. providing a piston in said piling;

b. sealing one end of said piling against the underlying ground;

c. filling with water the lower chamber of the piling between said piston and the ground;

d. closing the upper chamber in the interior of said piling immediately above said piston and

e. evacuating the closed upper chamber to draw said piling downwardly with respect to said piston and the ground and to draw a portion of the ground into said lower chamber.

2. The method of claim **1** including the step of hydraulically agitating the ground opposite the piston after the piling has been sealed against the ground.

3. The method of claim **2** including the step of subsequently removing matter from the lower chamber below the piston.

4. The method of claim **1** including the step of introducing a particulate solid into the lower region of said piling and thereafter compacting said particulate solids by applying pressure in the piling above the solids.

5. The method of claim **4** including the step of applying pressure to the upper region of the piling to raise the piling to a desired level.

6. An apparatus for driving tubular piling including;

a. a piston mounted for reciprocating on said piling and dividing said piling longitudinally into two chambers;

b. means for filling a first of said chambers with water, said filling means including a pipe extending longitudinally in said piling; and

c. means for closing and evacuating the second of said chambers, said closing and evacuating means including a head on said piling;

d. said piston having an aperture for receiving said pipe slidably therethrough, said head having a first aperture communicating with said pipe and a second aperture communicating with said second chamber.

7. Apparatus according to claim **6** in which the head is detachably mounted on said piling.

8. Apparatus according to claim **7** including a collar slideably mounted on the exterior of said piling.

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