Aug. 6, 1968 F. RUSCHE 3,395,543

METHOD FOR DRIVING THIN WALL PIPE PILES

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FIG. 4

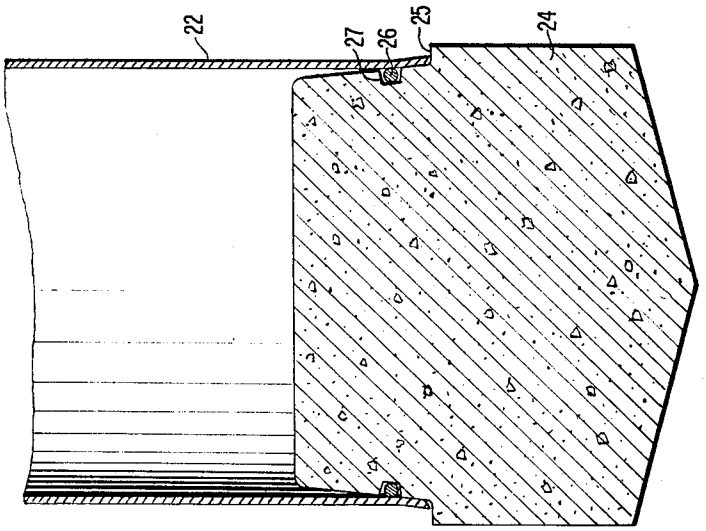



FIG. 3

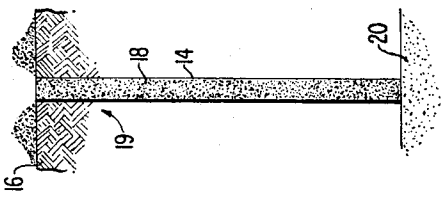



FIG. 2

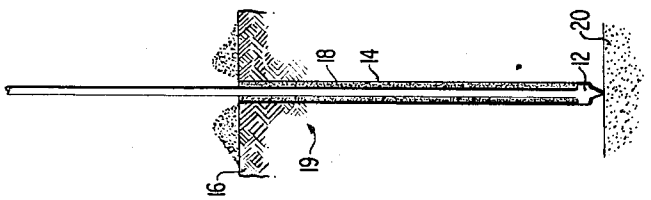
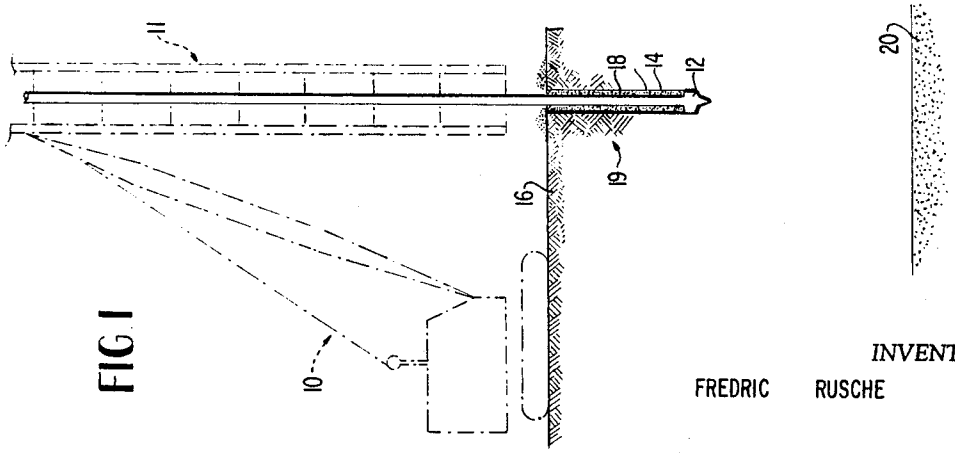



FIG. 1




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# METHOD FOR DRIVING THIN WALL PIPE PILES

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FIG. 9

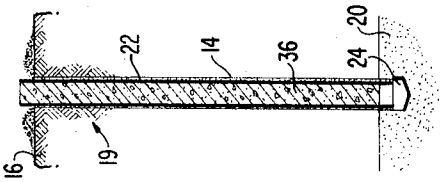



FIG. 8

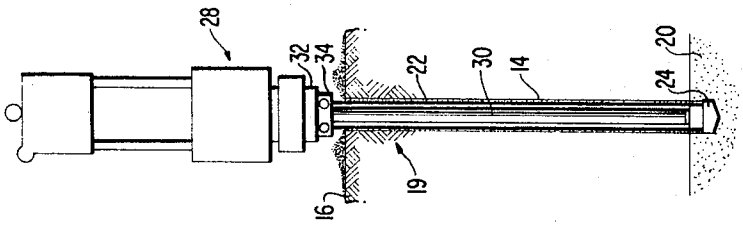



FIG. 7

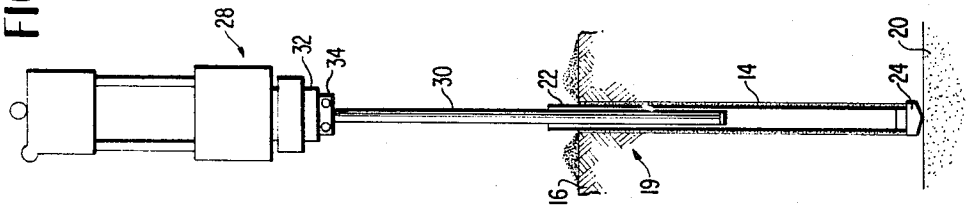



FIG. 6

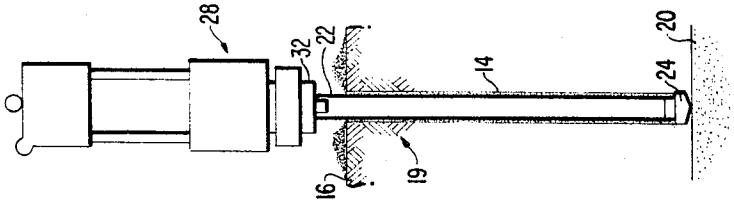
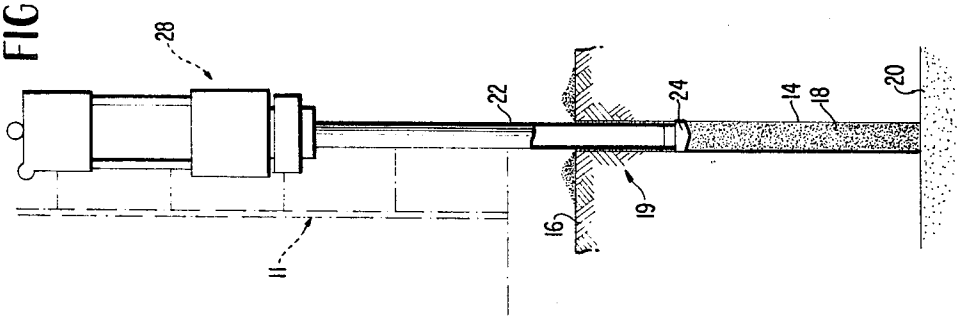



FIG. 5



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3,395,543

# METHOD FOR DRIVING THIN WALL PIPE PILES

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7 Claims. (Cl. 61—53.7)


## ABSTRACT OF THE DISCLOSURE

This method is applicable for driving thin wall pipe pile where a hard bearing strata is overlaid by drillable strata. A hole is first drilled down to the bearing strata through the overlying strata, utilizing drilling mud which is left in the hole. A driving point is tightly installed on a thin wall pipe, and the latter is driven down the hole by impacts on its top until the point reaches the bearing strata. Then a mandrel of heavy steel tubing is loosely installed in the pipe, the lower end of the mandrel bearing upon the driving point and the upper end of the mandrel having a driving ring which engages the top of the pipe. The point is driven into the bearing strata by hammer blows on the mandrel, most of the driving energy being imparted to the point so that the latter pulls the pipe down with it, the elastic shortening of the mandrel under driving being less than that of the pipe. After the point has been driven home, the mandrel is removed and the pipe filled with concrete.


## BACKGROUND OF INVENTION

### *Field*

The invention is in the field of hydraulic and earth engineering, stable structures in shifting media, piles, with installing.

### *Prior art*

The installation of pile in a predrilled mud-filled hole is known. However, with this method, the pile is not seated home into bearing strata. Also, by another method, a flat or cone shaped steel boot is welded to the bottom of a pipe pile and the pile is driven by a heavy hammer driving directly on the wall of the pipe. When using this method, the full allowable structure of the pile is not realized because either the springy action of the pile will prevent the necessary pile penetration or the thin pipe wall will be wrinkled or accordioned by the hammer.

Alternatively, a thin wall pipe pile is driven with an internal solid heavy duty steel mandrel which transmits the driving energy of the hammer to the top of the pile and/or the boot plate. Or, as a variation of this, the mandrel drives on the top of the pile and/or a reinforced boot sleeve. Usually in this type of installation the boot plate is torn loose from the steel shell or, in the variation, the interior sleeve proves to be prohibitive in cost. In addition, from about 10% to 60% of the thin wall pipes will collapse when adjacent piles are being driven, due to increased soil pressures and soil displacements. This method necessitates the use of long leads and/or doodle holes, as the mandrel must be inserted prior to the beginning of the driving operation so that it is possible to drive the thin pipe down through any hard strata that might be encountered either near the ground surface or somewhere above the desired bearing strata.

### *Objects*

The object of this invention is to provide a method whereby thin wall pipe piles may be seated home into subterranean bearing strata through overlying strata which might impose hard driving conditions upon the pile. A further object is to provide a method which utilizes a driving mandrel for the final driving, but which avoids the necessity of long leads or doodle holes is to provide a method



whereby thin wall pipe piles can be driven closely adjacent to one another without causing collapse of adjacent previously driven piles.

Rapidly increasing material and labor costs in the construction industry are forcing designers and contractors to search for new ways to increase the load carrying capacity of piles. At the present time, in most areas of the country the corrugated shell type pile is being loaded to its structural limit. Capacities generally assigned to corrugated shell type piles have been determined by considering the pile purely and simply as a structural member and this consideration alone is the controlling design factor as adequate seating of the pile in the desired bearing strata is accomplished through mandrel driving whereby the hammer blow can be adequately transmitted to the pile tip. Therefore, in most areas of the country where good bearing stratas are available at economically depths, the shell pile is being loaded to its design limit and more, when considering the word "limit" in the light of acceptable structural design practice. So in general when considering the corrugated shell type pile, increased capacities means larger diameters and costly pile.

The carrying capacity of the thin wall pipe pile, however, has been considered from a much more conservative viewpoint, and the structural adequacy of the pile has not been the limiting factor in the carrying capacity of this pile. The limiting factor in this case has been the ability of the contractor to properly seat the pile in a designated bearing strata.

The thin wall of the pipe pile gives it spring-like characteristics which are not conducive to the efficient transmission of energy to the point of the pile, and usually where mandrels have been used, driving has been accompanied by collapse problems brought on by soil displacement.

Structural excellence and the potential economy of the thin wall pipe pile have long been recognized by experts, and it has long been felt that the thin wall pipe pile would rapidly come into its own as a high capacity pile when the pipe itself could be adequately and properly seated in the bearing strata without damage to the pile.

At the present time the pipe pile is being assigned a load bearing value which varies from 30% to 70% of the actual structural capacity.

When adequately seated however the whole structural capacity of the pipe pile can be utilized provided the pipe itself has not been damaged during the driving operation.

The structural analysis for the pipe pile is identical to the structural analysis for a short concrete filled pipe column, provided of course the structural integrity of the thin wall pipe has not been damaged during the operation. If new methods of installation can be developed which will allow the designer to make use of the full structural capacity of the thin wall pipe pile then a whole new market potential is available to the qualified contractor.

The invention will be fully described and illustrated by the drawings, in which:

FIGS. 1, 2 and 3 diagrammatically illustrate the predrilling steps;

FIG. 4 is a fragmentary cross-section illustrating the pre-cast drilling point installed on the lower end of a pipe pile;

FIGS. 5 and 6 are diagrammatic cross-sections illustrating the initial driving steps;

FIG. 7 is a digrammatic cross-section illustrating the installation of the mandrel;

FIG. 8 is a diagrammatic cross-section illustrating the final driving step; and

FIG. 9 is a diagrammatic cross-section showing a driven pipe pile with concrete cast in situ.

Referring now to the drawings, in which like reference

numerals denote similar elements, a typical drilling and pile driving rig **10** having leads **11** is first set up with a drill **12** to drill a hole **14** downwardly through the earth **16** by conventional fluid wet drilling. The drilled hole is kept from caving in by the drilling mud **18** which is provided in clay soils by the material itself, or by the introduction of drilling mud or bentonite into the drilling water when working in sandy soils. Hole **14** is drilled down through upper stratas **19** to a desired bearing strata **20**, whereupon drill **12** is lifted out, leaving the drilling mud **18** in the hole. Normally hole **14** is made equal to or slightly larger than the diameter of the pile to be driven, although the hole could be slightly smaller than the pile. This step eliminates the possibility of hard driving through upper stratas **19**, and it also eliminates the problems of soil displacement during the driving operation.

Next, a thin wall pipe pile **22** is raised in leads **11** and a tapered, high strength pre-cast driving point **24** is positioned on the ground beneath the lower end of pile **22**. Normally it is held on top of a crane mat. For example, if the pile is 12.75 inches outer diameter, a wall thickness of 0.125 inch through 0.215 inch would be considered "thin." For a 16 inch outer diameter, a wall thickness of 0.172 inch to 0.250 inch would be considered "thin." Then one or two blows of hammer **28** will seat the lower end of pile **22** against the shoulder **25** on point **24**. An O ring gasket **26** in an annular groove **27** around point **24** seals the interior of pile **22** against the entrance of water and drilling mud. The shape and mechanical characteristics of the point and its connection with the pile may vary.

After driving point **24** is installed, pile **22** is positioned over hole **14**, and driven downwardly by hammer blows directly on its top. As pile moves downwardly in the hole, the drilling mud **18** is placed under compression so that it is forced upwardly along the surface of the pile, apparently forming small channels along the surface of the hole. Driving directly on the top of pile **22** ensures until point **24** reaches bearing strata **20** or until hard driving is encountered.

When driving point **24** reaches bearing strata **20**, a loose-fitting steel mandrel **30** is raised in the leads and installed into pipe pile **14**. Mandrel **30** which is made of heavy steel tubing closed at its bottom end by a suitable steel plate, has ears at its upper end which tie into the hammer bonnet **37** and an upper driving ring **34**. For example, if the mandrel is 12 inches outer diameter, its wall thickness would be from 1 inch to 2 inches, and for a mandrel of about 15.5 inches outer diameter, the wall thickness would be from about 1.5 inches to 2.0 inches.

FIG. 8 illustrates the completion of the driving operation in which driving point **24** is seated home in bearing strata **20**. During this step, hammer **28** drives directly on the top of mandrel **30** which, in turn, transmit the driving force directly onto the top of the concrete driving point **24**. The thin wall pipe **22** is both dragged down into the soil by the wedged grip which the concrete point has on it, and at the same time it is also driven into the soil by the action of the mandrel on the top of the pipe. From about 75% to 90% of the driving energy is transmitted directly to point **24** due to the fact that the wall section of mandrel **30** is much heavier than that of the pipe and hence its elastic shortening under hammer load is much less than that of the pipe. After the pile has been driven to the required high blow count, the mandrel is withdrawn and the next pile is driven in a similar manner, the driven piles being filled with concrete **36** as illustrated in FIG. 9.

Utilizing the above method, thin wall pipe piles may be successfully and economically driven to blow counts heretofore unattainable for this type of installation. The necessity for very long heavy leads and hence larger and more expensive pile drivers is eliminated and, alternatively, no doodle holes are required for installing the mandrel. Therefore, by the use of this method economies of installation can be realized by greatly increasing the design capacities of thin wall pipe piles.

The invention is not limited to the details disclosed and described herein, but is intended to cover all substitutions, modifications and equivalents within the scope of the following claims.

I claim:

**1.** The method of installing a thin-wall pipe pile which comprises,

wet drilling a hole downwardly through earth to a desired bearing strata and leaving drilling mud in the hole after the wet drilling,

driving a thin wall pipe pile having a driving point on the lower end thereof downwardly into the hole until the point substantially reaches the bearing strata by means of pile-driven hammer blows applied to the top of the pile and thereby forcing the drilling mud upwardly alongside the pipe pile to the exterior of the hole,

then inserting into the pipe pile a loose-fitting mandrel until the lower end thereof engages the driving point,

and applying pile driver hammer blows to the mandrel until the driving point is seated home in the bearing strata to a desired blow count.

**2.** In the method recited in claim **1**, the subequent steps of removing the mandrel from the pile and filling the latter with concrete.

**3.** The method recited in claim **1**, and, simultaneously with the application of pile driver hammer blows to the top of the mandrel, applying part of the force of the hammer blows to the top of the pile.

**4.** The method recited in claim **3**, wherein the mandrel is of greater effective wall section than the wall section of the pipe pile, whereby the resultant force of hammer blows applied to the top of the pile is minor in comparison to the resultant force applied to the point.

**5.** The method of installing a thin wall pipe pile which comprises,

wet drilling a hole downwardly through earth to a desired bearing strata and leaving the hole substantially filled with drilling mud,

forcing a thin wall pipe pile having a driving point engaged on the lower end thereof until the point substantially reaches the bearing strata and thereby forcing the drilling mud upwardly alongside the pipe pile to the exterior of the hole.

and then driving the pipe pile downwardly until the point penetrates the bearing strata by applying force of hammer blows simultaneously to the driving point and the top of the mandrel.

**6.** The method recited in claim **5**, wherein the force of hammer blows is applied by a mandrel which engages both the driving point and the top of the pile.

**7.** The method recited in claim **6**, wherein the compressive elasticity of the mandrel is less than the stretch elasticity of the pile.

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JACOB SHAPIRO, *Primary Examiner.*