Jan. 15, 1963 J. SOLER NADAL 3,073,124

METHOD FOR PILES CAST-IN-SITU

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FIG. 9

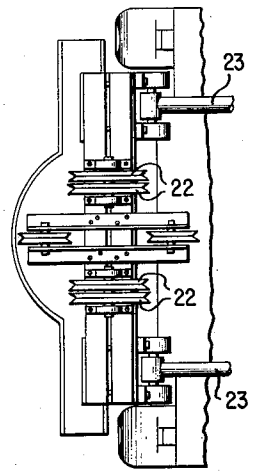


FIG. 1

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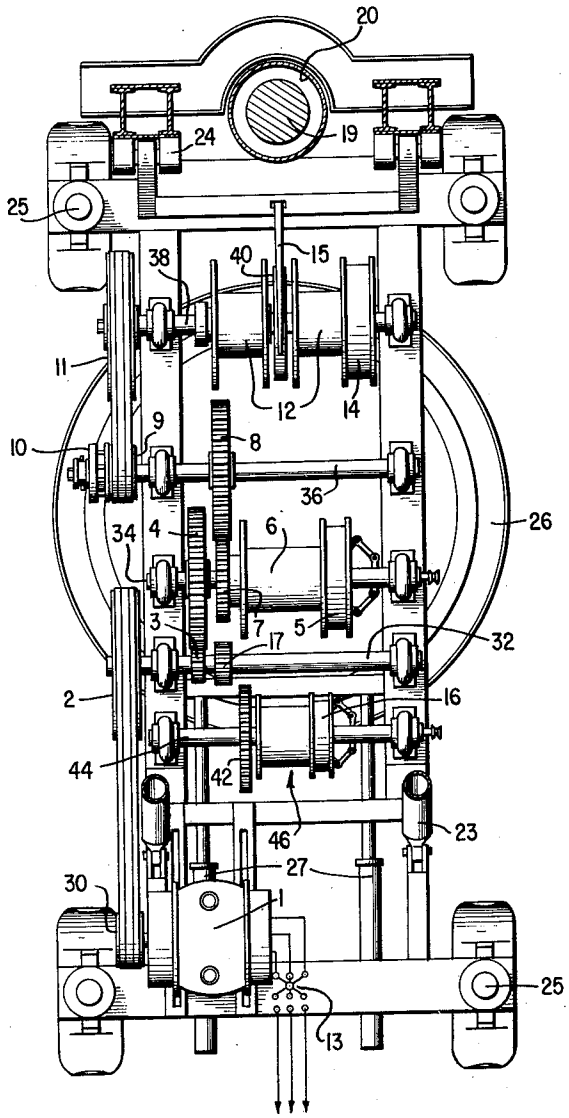
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FIG. 2



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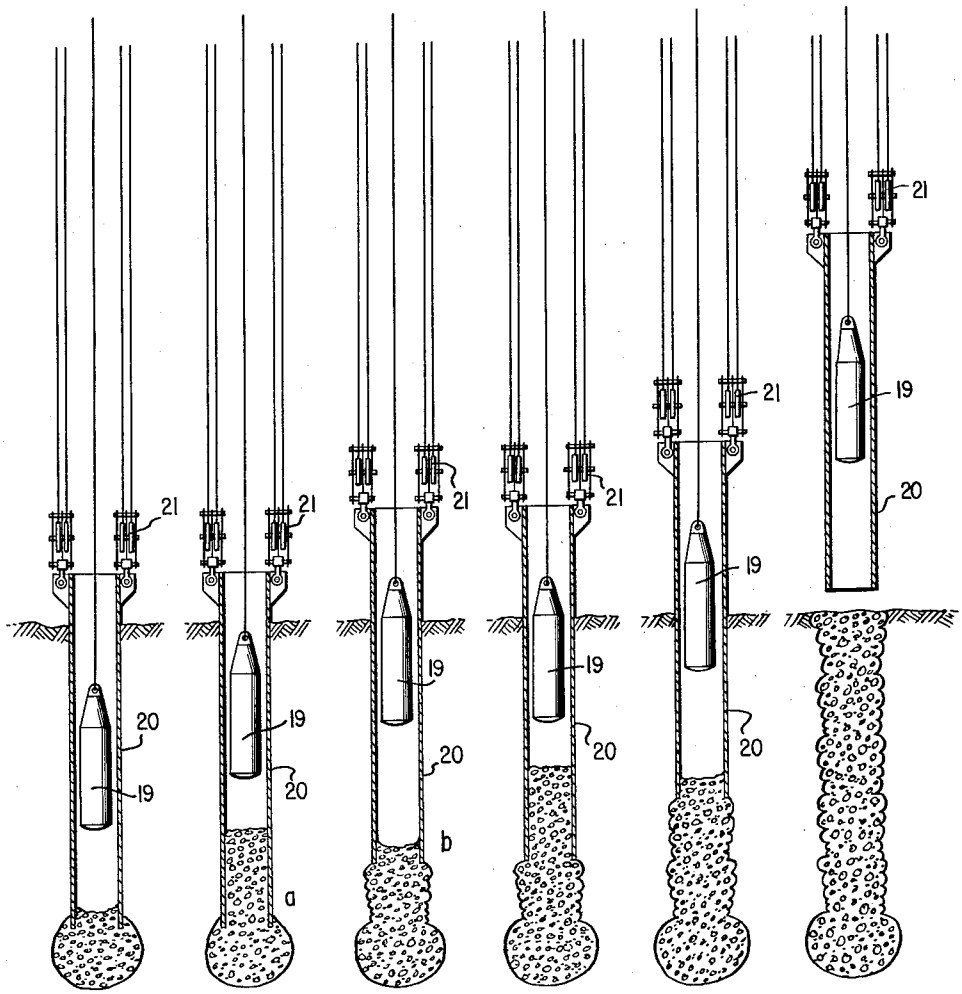
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FIG. 3 FIG. 4 FIG. 5 FIG. 6 FIG. 7 FIG. 8



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METHOD FOR PILES CAST-IN-SITU

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This invention relates generally to piles cast-in-situ, and more particularly to a method of and rig for constructing such piles.

A number of methods for constructing this type of pile are now being used. First, one of a number of boring methods must be used. The first boring method is large diameter rotary drilling, either with or without core recovering. The second method is the driving of a casing pipe into the ground and extraction of the earth therein by means of a spoon, bailer, or hammer grab bucker. The third method is the driving of a casing pipe into the earth by alternately rotating the casing and then extracting the removed material within the casing as described above. The fourth method is to place concrete of a dry consistency or a precast plug at the bottom of the casing pipe and tamp on the plug with a heavy drop hammer whereupon friction between the plug and the casing will force the casing pipe downward and into the ground. A fifth method is to drive a casing pipe, by a drop hammer, the length of which is approximately equal to the length of the casing, with the drop hammer striking the upper part of the casing or striking the soil to drive the casing into the earth. A sixth method is the utilization of a non-retrievable closed-end casing pipe, either corrugated or smooth, which is driven into the ground by means of a drop hammer. The casing need not have a closed end, for a wooden pole or precast concrete plug may be housed in the lower end thereof, instead. In any case, the drop hammer will act on the lower end of the casing.

Depending upon the boring method used, the method of forming the concrete piles will vary. With the first three boring methods, a pipe of smaller dimensions than the casing is placed therein and both are gradually recovered when the concrete is poured through the smaller pipe, with special care being taken to assure that the level of concrete is always above the lower end of the casing pipe to prevent a disturbance in the continuity of the concrete which would be caused by flow of the fresh concrete filling the bored hole.

Another method is to use a special spoon or other device which opens after it has been partially introduced into the previously poured concrete to let the fresh concrete flow into the casing pipe. The jaws of such a spoon are opened by means of a suspension wire cable line, or by movement of a chain which is connected to a trap door at the bottom of the spoon.

A further method of forming the concrete piles is to place a precast circular element in the upper portion of the casing, the diameter of which is smaller than that of the inner surface of the pipe or casing. A packing of rubber, clay, or any other suitable material that permits a good adjustment with respect to the casing pipe is introduced, and then the concrete is poured. The concrete plate, which may be a large piece of plastic concrete which is retained by a wire mesh, is suspended by a reinforcing steel cage. When the concrete is poured, the water is forced from the casing pipe because of the pressure of the concrete, either through the bottom, or by a small pipe located within the casing. When the pouring of concrete is completed, the casing pipe is removed. Compressed air may also be used to produce the compression of the concrete, in order to expel the water therein, in which case the poured concrete acts as a piston within the casing.

With the fourth system, when the desired depth is reached by boring, the lower end of the casing is plugged by concrete of a dry consistency, the casing is suspended from the rig, and the lower portion of the concrete plug is driven through the bottom of the casing by a ramming operation. Then, a quantity of concrete is poured into the casing which is rammed and hammered after a portion of the casing has been raised from the soil, and this process is continually repeated until the entire concrete pile is formed. With the fifth boring system, the concrete is poured in stages with the drap hammer resting on the upper surface of the poured concrete while the casing is pulled upwardly a short distance. This is continually repeated until the full concrete piling is formed. In this case, however, the length of the concrete shaft is controlled by the length of the drop hammer which projects out of the upper end of the casing.

With the last system of boring, since the closed-end casing is to remain in the ground, concrete is poured into the casing and may be rammed or vibrated to assure proper dispersion.

However, with all of these systems of boring and forming the concrete pile an erosion of the concrete may arise upon being discharged with above-mentioned spoon, or because the upward lifting of the casing creates a vacuum at the lower end of the casing and pulls the surrounding soil into the space which is to be occupied by the concrete, thus weakening the pile and causing an erosion thereof.

Furthermore, breaks or gaps in the concrete pile shaft can be caused by raising the casing pipe to a position above that of the concrete column. Furthermore, gaps are almost always produced because of the friction between the concrete and the casing which causes the poured concrete to be lifted along with the casing. This produces pockets and gaps within the concrete proper, which, of course, will weaken the finished pile. With the fourth system mentioned, if the concrete is of too loose a consistency, then of course the drop hammer will sink into the concrete. If it is of too dry a consistency, then the friction between the concrete and casing will cause the concrete to be lifted along with the casing, producing a suction effect and drawing the surrounding soil into the area which should be occupied by the pile, thus weakening the final strength of the pile. Thus, the concrete consistency must be perfect and this condition is extremely difficult to attain, thereby rendering this system impractical.

With these defects of the prior art in mind, it is the primary object of this invention to provide a method of constructing piles cast-in-situ and apparatus for carrying out this method which is extremely economical, may be performed as quickly as may of the prior art operations and, most important of all, creates a concrete piling which has no pockets or gaps therein and which is always formed so as to be of the correct strength and not susceptible to concrete erosion.

Another object of this invention is to provide a device of the character described wherein the raising of the casing and the tamping of the concrete are performed simultaneously so as to eliminate the possibility of creating a suction by the raising of the casing which may carry some of the concrete therewith.

A further object of this invention is to provide a device of the character described wherein the raising of the casing is easily performed because it is accomplished by using a portion of the kinetic energy of the falling drop hammer.

The foregoing objects and others ancillary thereto are accomplished according to a preferred embodiment of the invention, wherein a rig is provided with a suitable clutching system and uses a drop hammer which is heavier than that which would be required to compact the poured

concrete to expel it from the bottom of the casing. The drop hammer is raised by the use of a motor and winch and is allowed to fall by gravity whereupon the unwinding drum is clutched to another drum upon which a cable is wound and is connected to the casing. As the drop hammer falls, a portion of its kinetic energy is used to raise the casing. Since there is a clutch connection between the two drums, if it is desired to more fully compact the concrete or to form a bulb in the concrete pile, the clutch may be disconnected and the drop hammer used to tamp the concrete to form the bulb. Under these circumstances, since the drop hammer is much larger than would be normally necessary to tamp the concrete, the hammer need not be raised to its full height.

The novel features that are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawings, wherein like reference characters indicate like parts throughout the several figures and in which:

FIG. 1 is a side elevational view of the rig with parts broken away for purposes of clarity;

FIG. 2 is a plan view of the device illustrated in FIG. 1, taken on line 2—2, FIG 1;

FIGS. 3–8 are vertical sectional views taken through the casing, drop hammer and the ground, and also illustrating the concrete during the various stages of operation of forming a concrete pile within the ground and removing a casing at the same time;

FIG. 9 is a fragmentary plan view taken from line 9—9, FIG. 1.

Referring now more particularly to the drawings, it may be seen that there is provided a frame on which a motor 1 is mounted with its pulley 30 in alignment with a second pulley 2. On the same shaft 32 with pulley 2 is a pinion 3, driving a gear 4 on a different shaft 34 and onto which a hammer hoist drum 6 is loosely disposed but may be locked thereto by means of a clutch 5. All of the parts described so far are those which are commonly used in conventional drives for rigs. However, in the present invention the following additional structure is provided.

This structure includes a gear 8 fixed on shaft 36 and driven by a pinion 7 which is fixed to drum 6 and driven thereby so that rotation of gear 8 will be the opposite of the rotation of the hammer hoist drum 6. A pulley 9 is fixed to shaft 36 and is in alignment with another pulley 11 fixed to shaft 38. Disposed upon shaft 38 are a pair of casing hoist drums 12 from which the casing is suspended, through a pair of cables and a set of tackles 21 and 22 disposed above the casing and at the top of the vertical rig legs. Each tackle may comprise several pulleys so that each cable may run in a conventional manner from a drum 12 over a first pulley in tackle 22, down and under a first pulley in tackle 21, up and over a second pulley in tackle 22, down and under a second pulley in tackle 21, and back up to tackle 22 where its end may be secured to a suitable fixed element.

The pulley 11 is arranged so that it will only drive in one direction, by incorporation of a directional clutch or a so-called one-way clutch. A gear 40 is placed between the two drums 12, and a gear tooth pawl 15 engages the teeth of the gear to prevent it from turning in the opposite direction because of the casing weight while the hammer is being lifted. To prevent the force and shock of the drop hammer blows from driving the casing, the drums 12 are also braked from turning in said opposite direction by means of a counterweight brake 14 which has a strap passing thereover and a heavy weight depending therefrom. Thus, the pulley 11 and

drums 12 may only turn in one direction except when pawl 15 is pivoted out of engagement with the ratchet gear 40 to release the drum axle and permit paying out of the casing hoist cables, as is necessary when the rig is moved to another location for hoisting another casing.

A pinion 17 is connected to shaft 32, and is disposed to engage gear 42 on shaft 44 adjacent thereto, on which a concrete bucket hoist 46 is disposed. A clutch 16 is provided to engage the gear 42 with the pinion 17 to drive the concrete bucket hoist 46 when desired. Of course, this pinion 17 will be disconnected from the system while the boring process is taking place.

A cable is wound upon the drum of the hoist 46 and is connected to the concrete bucket 18. The bucket is mounted to move vertically upon the rig legs, and the center of gravity of the bucket is located below the point at which it is supported when it is empty but raises above the supporting point when it is filled with concrete. Thus, when filled with concrete the bucket will have a tendency to tip toward the casing, so that when the bucket is disposed at the upper end of the casing it will automatically tip and pour the concrete inside the casing pipe. However, once it is emptied the bucket will resume a vertical position and remain this way until it is lowered and again filled with concrete.

A clutch 10 is provided which has a number of pins which may be inserted into pulley 9, so that when member 10 is moved away from pulley 9 the pins are withdrawn therefrom and the axle will turn freely. However, when the pins are inserted into the pulley 9, the pulley will turn with the axle, and in this manner the drum 12 may be disconnected from the system.

A self-displacing or walking leg arrangement is provided upon the rig so that it may change its relative position when desired.

The frame thereof is constructed with a double-skid base, two vertical legs, and two batter legs.

The vertical legs rest on the ground by means of an Ω-shaped piece serving as casing pipe leader. These vertical legs may rotate around two sturdy pins 24. The outer skid base rests on the ground by means of four hydraulic jack mobile feet 25. Two hydraulic jacks 27 make the outer skid slide on the inner skid base.

A circular piece is suspended from the inner skid base. This piece possesses rotary motion by means of rollers, no vertical movement being possible.

The batter legs are formed by two pieces telescopically coupled. The upper piece may be displaced by hydraulic jacks housed in the fixed lower piece.

The operation of the device will be as follows:

The boring may be performed by any suitable system as long as an open-ended casing pipe is driven into the ground and is of the type which may be connected to a hoisting rig. Then, once the desired boring depth is attained, the casing pipe is suspended from the rig and the plug of concrete which is in the lower end of the casing will be partially expelled from the lower end of the casing by tamping with the drop hammer, as illustrated in FIG. 3, wherein it is shown that the casing pipe is sunken in the ground, and the plug of concrete at the lower end thereof is hammered out the lower end of the casing by means of the drop hammer.

Then, the bucket 18 is used to pour a quantity of concrete into the casing, which may range from 20 to 40 inches in height, as illustrated in FIG. 4. The hammer is raised by applying power from motor 1 through pulleys 30 and 2, shaft 32 and meshing gears 3 and 4 to the shaft 34. Clutch 5 is engaged to cause drum 6 to turn and hoist the hammer. Gears 7 and 8 and shaft 36 turn with the drum, but this motion is not transmitted to the casing hoist drums 12 because the clutch 10 is disconnected. When the hammer has been raised to an appropriate height, clutch 5 is disengaged and clutch 10 engaged, the hammer will fall by gravity. The resultant turning of the drum 6 is transmitted through

gears 7, 8, shaft 36, pulleys 9, 11 and shaft 38 to the casing hoist drums which turn in the opposite direction to lift the casing. The gears 7 and 8 and pulleys 9 and 11 constitute a speed reduction gearing by reason of their different diameters so that the casing is lifted an appropriate distance less than the distance of the fall of the hammer. The clutch 5 is then reengaged and clutch 10 disengaged to drive the hoist drum to again lift the hammer. The hammer may then be again dropped with clutches 5 and 10 respectively disengaged and engaged as explained above. Thus, the tamping or hammering operation is continued simultaneously with the raising of the casing, as indicated in FIG. 5. This process is continually repeated until the casing is lifted out of the ground, as indicated in FIG. 8, and a concrete piling has been formed in the earth. It should be noted, however, that a small portion of concrete should always remain in the lower end of the casing so as to prevent the surrounding soil from entering the space which should otherwise be occupied by the piling, which would have the effect of weakening the finished pile.

It should be noted that when the hammering is to take place the clutch 10 is connected so that as the drop hammer falls the drum 6 rotates to allow cable to unwind and this motion is transmitted to pulley 11 by means of pinion 7, gear 8 and pulley 9, so that the drums 12 wind up the cable and therefore raise the casing pipe somewhat. In other words, the kinetic energy of the drop hammer is used for partially extracting the casing pipe and ramming and expelling the poured concrete from the casing bottom. Since both of these operations occur simultaneously, continuity of the concrete piling is obtained. Consequently, the surrounding soil cannot displace the fresh concrete, and the concrete will not be entrained by the casing pipe and lifted along therewith.

The reduction gears between drums 6 and 12 along with the multiple pulley tackles 21 and 22 give the ram a mechanical advantage over the forces holding the casing in the ground. This mechanical advantage may be, for example, 40 to 1 so that the ram will exert a pull on the casing which is approximately 40 times its own weight. Also, due to the mechanical advantage the casing will be raised only $\frac{1}{40}$ of the distance the ram falls.

If the casing pipe is for any reason locked into the ground, the drop hammer being not sufficient to displace it, two phases of the three-phase electric motor can be interchanged by means of switch 13 and the motor will rotate in the opposite direction. Then hoist clutch 5 will serve to transmit directly full power to drum 12. If more power were found to be needed to dislodge the casing, the drop hammer can be lifted and released to assist the full power output of drum 12.

Although a certain specific embodiment of the invention has been shown and described, it is obvious that many modifications thereof are possible insofar as is necessitated by the prior art and by the spirit of the appended claims.

What I claim is:

1. A method of constructing piles of concrete or like material and which are cast in situ within the hollow of a tubular shell embedded within the ground, which comprises pouring a quantity of concrete or like material into an embedded shell, dropping a ram onto the poured material to compact the latter, and applying the kinetic energy of the dropping ram to said shell through a mechanical means to raise the shell simultaneously with the drop of the ram and immediately compress the material into the void left by the shell while the latter is being raised.

2. A method according to claim 1 wherein the distance that the shell is raised is proportional to and less than the distance through which the ram falls.

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