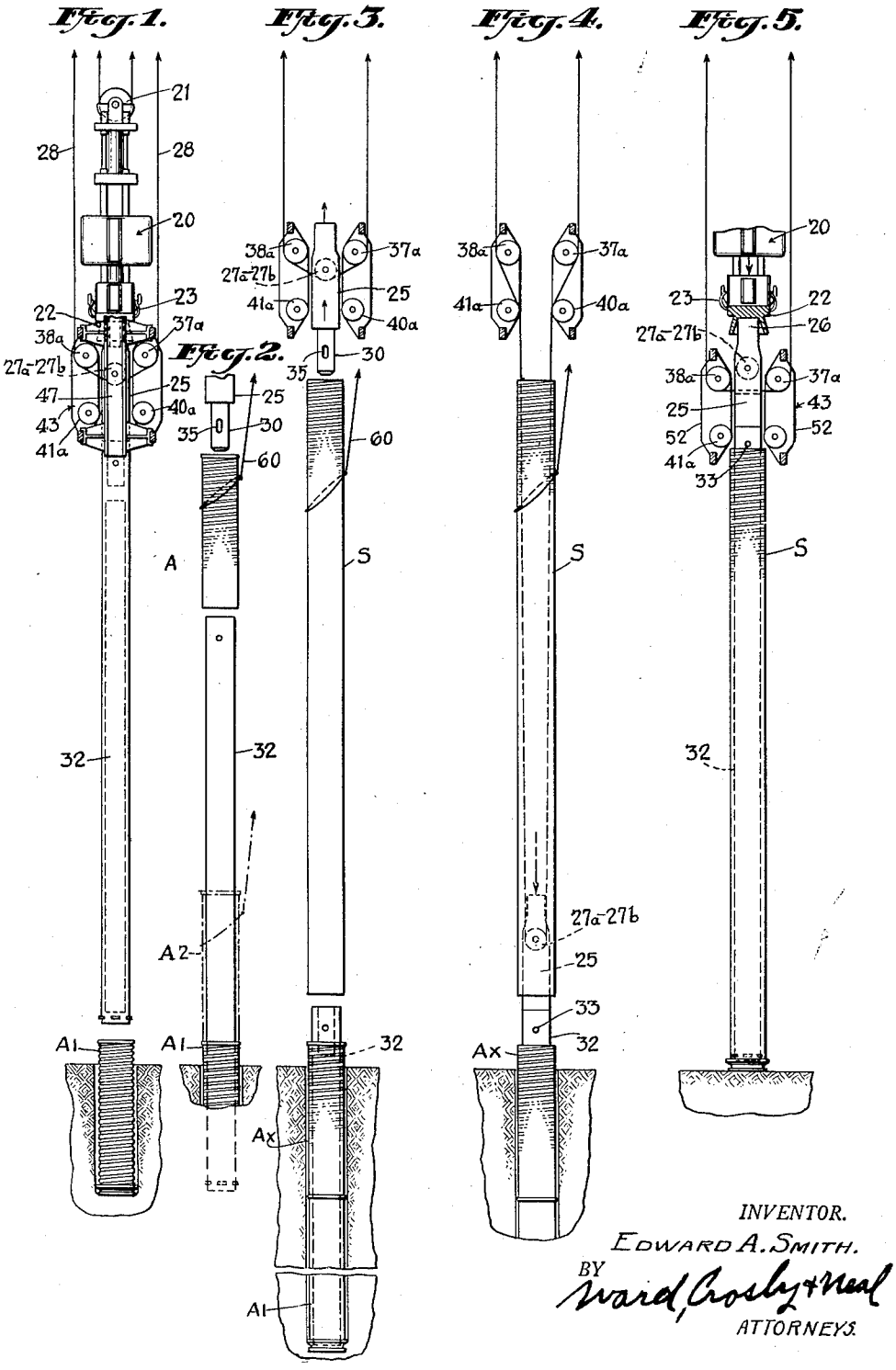
May 26, 1953 E. A. SMITH 2,639,589

METHOD AND APPARATUS FOR DRIVING PILE SHELLS

Filed Feb. 28, 1952 5 Sheets-Sheet 1



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METHOD AND APPARATUS FOR DRIVING PILE SHELLS

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Fig. 6.

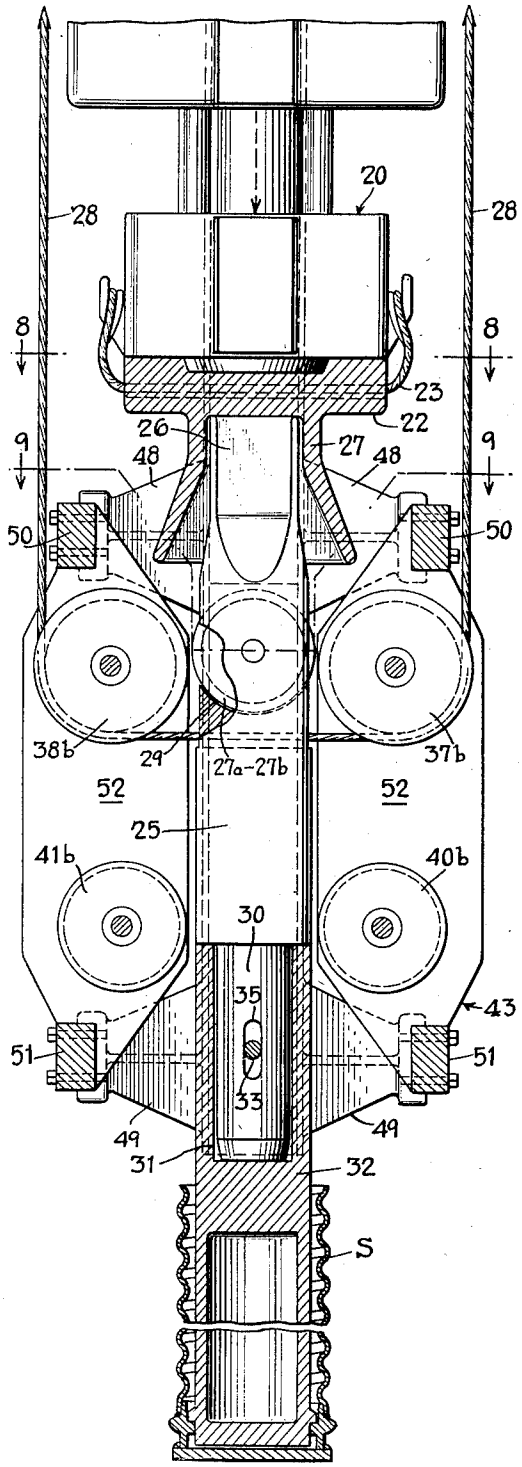
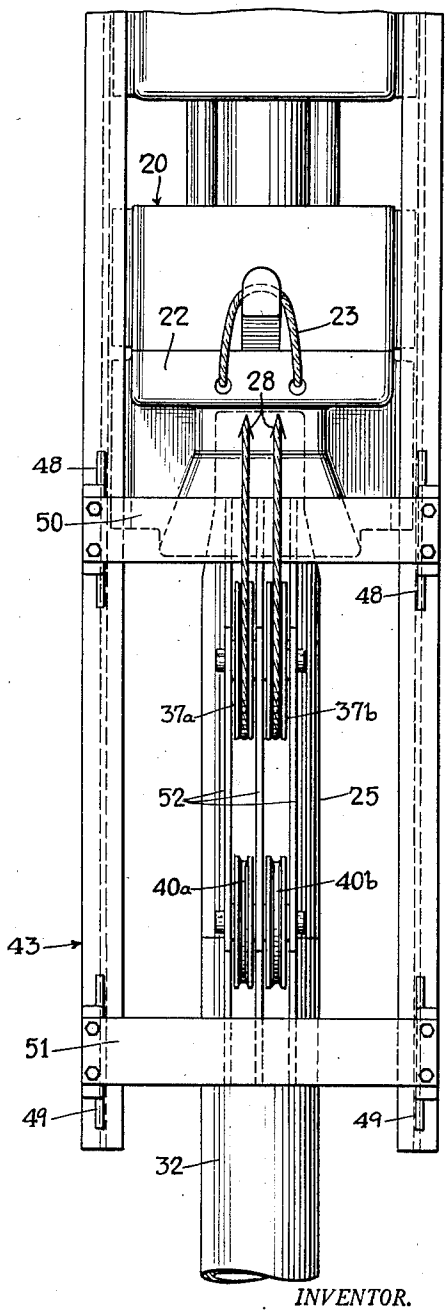


Fig. 7.



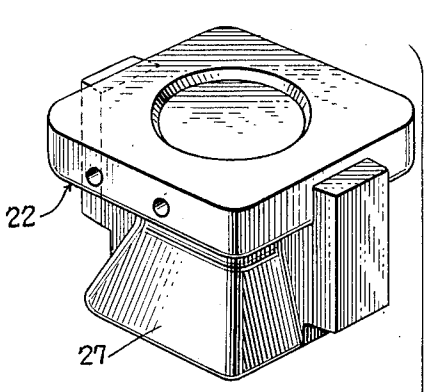
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METHOD AND APPARATUS FOR DRIVING PILE SHELLS

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Fig. 8.



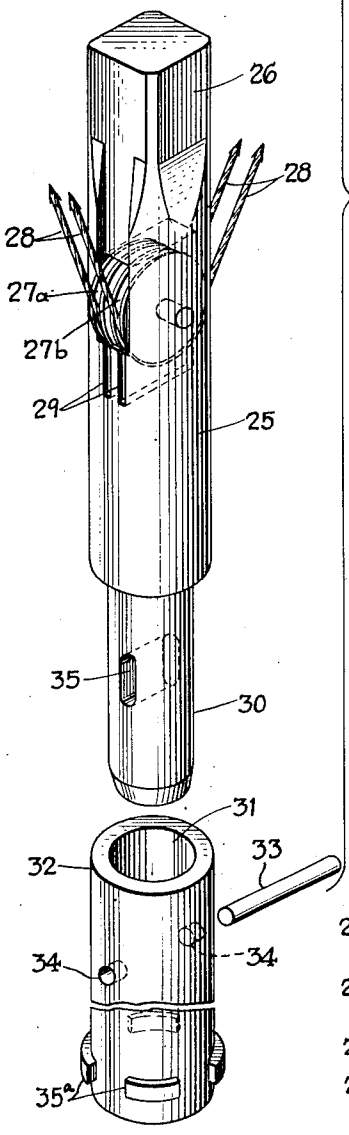


Fig. 10.

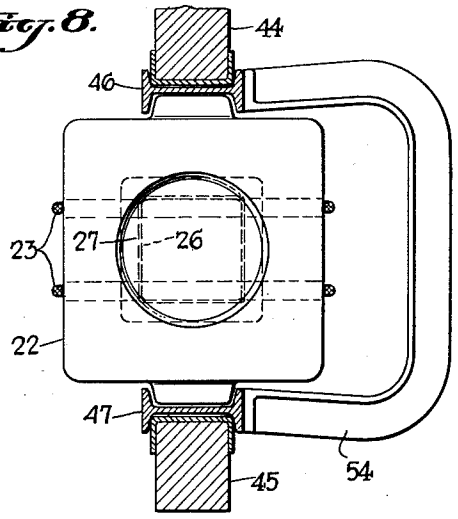


Fig. 9.

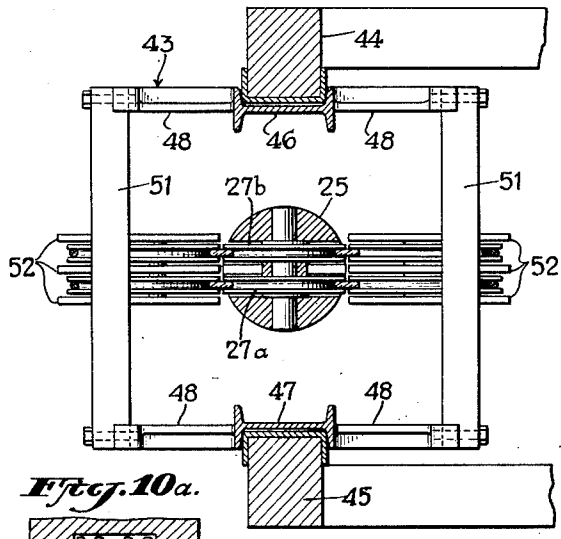
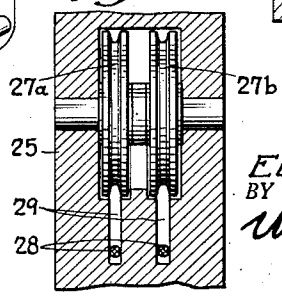


Fig. 10a.



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Fig. 12.

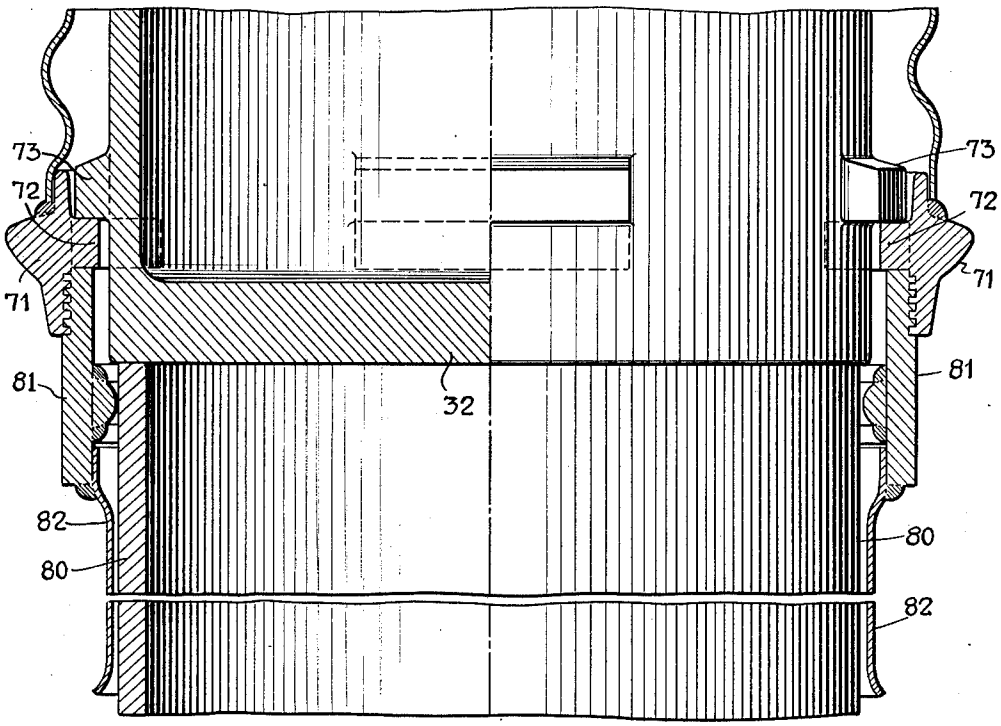
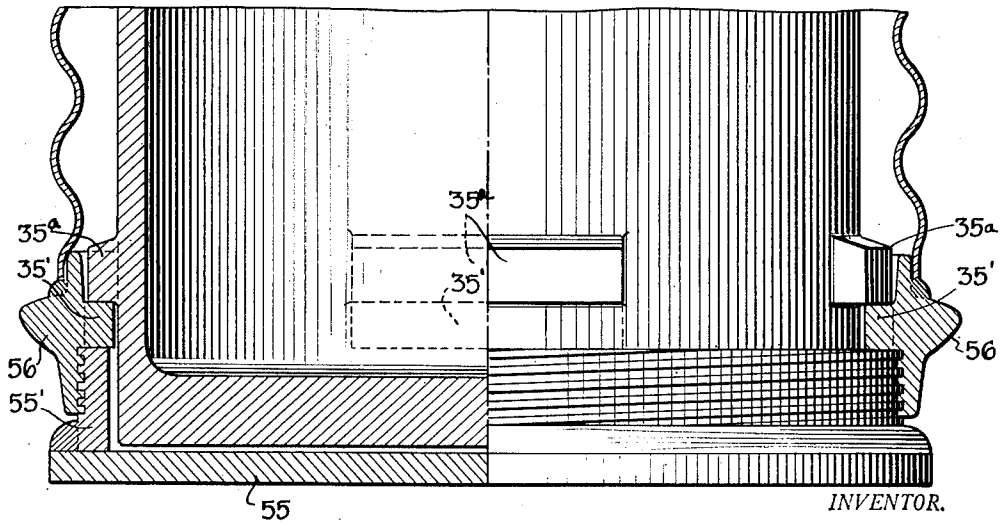


Fig. 11.



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Fig. 13.

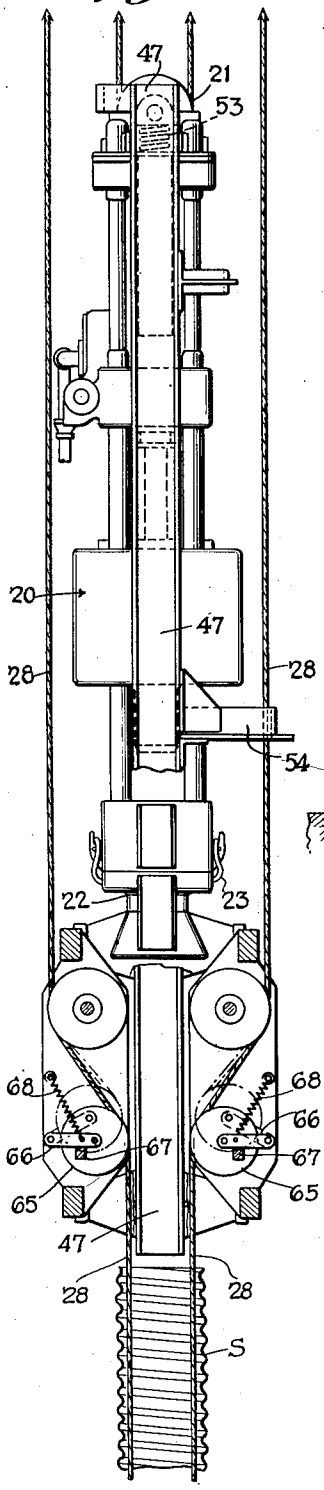


Fig. 14.

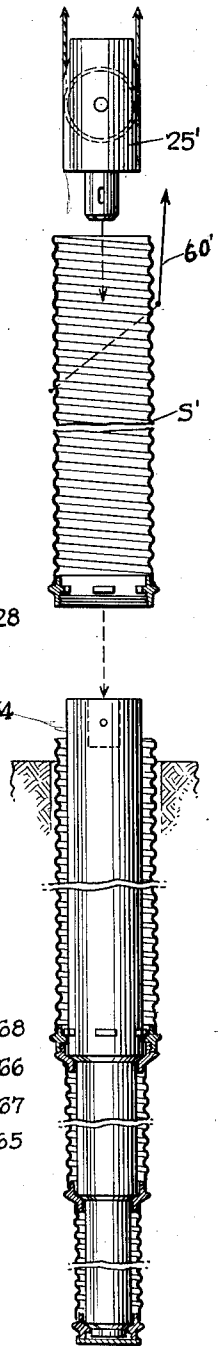


Fig. 15.

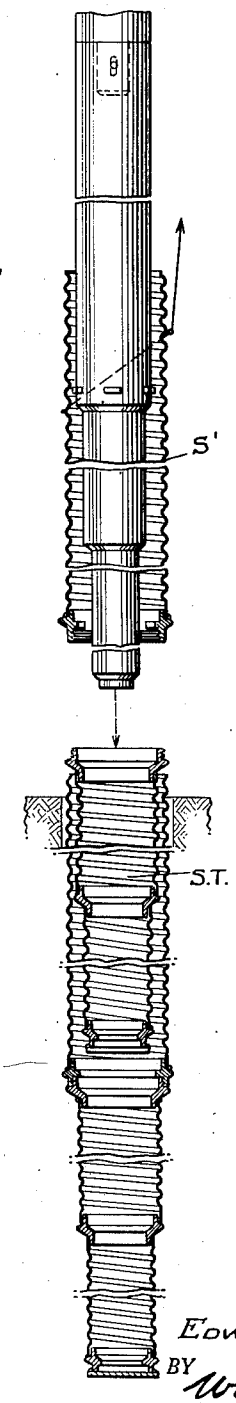


Fig. 16.

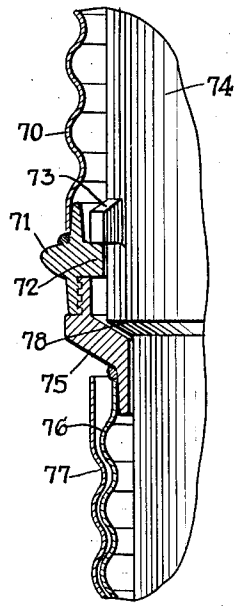
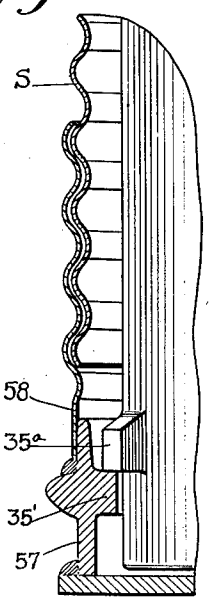


Fig. 17.



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UNITED STATES PATENT OFFICE

2,639,589

METHOD AND APPARATUS FOR DRIVING PILE SHELLS

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Application February 28, 1952, Serial No. 273,920

13 Claims. (Cl. 61—78)

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This invention relates to methods and apparatus for driving pile shells and is especially adapted for use in driving such shells by the use of a driving core therein, in those cases where the shell and core are so long that it is impractical to provide a pile driving rig which will extend high enough to provide the necessary "headroom" for assembling (or "shelling up," as it is termed) the core within the shell preparatory to driving the latter.

The invention is well adapted for use in the driving of such long pile shells which are made integral or are made of sections welded together to form a watertight unitary shell before it is driven. Also the invention is adapted for driving such long unitary shells of the so-called straight-sided type as distinguished from the well-known step tapered types made of sections which may be screwed together successively during the driving operation and which thus do not require such extensive headroom in "shelling up." With recent developments it has become possible readily to install such long straight-sided shells by placing them in pre-excavated holes formed by wet drilling methods so that despite the length of the shell and even though it is of relatively thin metal, it may be easily driven by a core therein into final position without tearing apart the shell walls. Yet, so far as is known, no entirely satisfactory or economical means or methods have theretofore been proposed for "shelling up" such unusually long unitary shells without providing a pile driving rig of unreasonable height to afford the necessary headroom to permit the shell to be suspended in an upright position and with a core above and in alignment therewith in position to be telescoped into the shell. The height of typical pile driving hammers is about 15 feet, and if for example according to frequent practice heretofore, the shell and the core are each only about 40 feet long, then the minimum headroom required amounts to a total of about 95 feet. This is a reasonable and practical figure with readily available pile drivers. If on the other hand it is desired to drive a unitary shell 80 feet long for example, requiring a driving core also about 80 feet long, then the total required headroom will amount to about 175 feet, which is a quite impractical figure for ordinary commercial pile drivers. Even if such long shells were made in two pieces to be assembled during the driving operations, the required headroom would still be about 135 feet or more—also generally an impractical figure.

One attempt to solve this problem involves the

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expedient of first driving a pipe into the ground of a diameter large enough to receive the shell in upright position so that the core may then be dropped into the shell with a saving of a certain amount of headroom in the "shelling up" operation. However, this method has a serious disadvantage where the piles are to be driven at points spread out over a considerable area, because the pile driver, after driving each shell, has to be moved back to the pipe for the next "shelling up" operation and this involves excessive and expensive travelling time for the pile driver back and forth. Also it has in some cases been the practice to avoid the problem by using so-called composite piles where long piles are required. Such composite piles consist of a pipe or H-beam forming the lower part, the upper part being formed of a shell which does not have to be of troublesome length, but this results in considerable extra cost because of the greater cost per foot of such pipe or H-beam portions as compared with light corrugated shells.

According to the present invention, the problem is solved by an economical and easily operated method and apparatus which involves first positioning the pile driving core generally upright and largely below the ground level in a tube which need only be large enough to receive the core alone and which thus may itself comprise one of the useful pile shells to be driven. This first shell may be driven in sections not requiring excessive headroom, if desired. After the core is thus positioned, a shell is suspended above and in alignment therewith. Then a core pulling means (one form of which is hereinafter referred to as a "messenger plug") suspended from the pile driver is lowered through such suspended shell and connected to the core, the pulling means then being raised to pull the core into "shelled up" position. Then the pile driver with the suspended shell and core therein is moved to the desired position for driving the shell. After driving the shell, the core in the thus driven shell is in position to again be "shelled up" in like manner with the next shell to be driven, and thus the pile driver does not have to travel back to or from the place of the initial "shelling up" operation. Thereby a great saving of time and labor with the expensive pile driving equipment is made possible.

Various further and more specific objects, features and advantages of the invention will appear from the following description, taken in connection with the accompanying drawings illus-

trating by way of example the presently preferred embodiments of the invention.

In the drawings:

Figs. 1 and 2 illustrate the manner in which a shell to be used for the first "shelling up" operation may be driven in sections;

Fig. 3 illustrates the manner in which the next shell to be driven may be suspended above the core which is shown positioned in the initially driven sectional shell;

Fig. 4 illustrates the manner in which a suspended core pulling means or "messenger plug" may be lowered through the suspended shell and attached to the core positioned in the sectional shell in the ground;

Fig. 5 illustrates the assembled or "shelled up" core, shell and shell boot ready to be driven by the pile driver hammer assembly;

Fig. 6 is an enlarged elevational view partly in section of a lower part of a hammer assembly, sheave arrangement and frame therefor and the "messenger plug" assembly operated thereby;

Fig. 7 is an elevational view taken at right angles to the view of Fig. 6;

Figs. 8 and 9 respectively are horizontal sectional views taken substantially along lines 8—8 and 9—9 of Fig. 6;

Fig. 10 is a perspective view showing in separated relation a hammer follower, the "messenger plug" and a core, as used in carrying out the invention;

Fig. 10*a* is a vertical sectional view taken in the plane of the axis of the sheaves which are mounted in the "messenger plug";

Fig. 11 is a vertical sectional view showing the details of a detachable boot construction which may be used according to the invention to close the lower end of the elongated pile shell;

Fig. 12 is a vertical sectional view showing a construction which may be used for forming an unusually long pile of the so-called composite type, the lower end of which comprises a pipe attached to the lower end of a corrugated shell;

Fig. 13 is an elevational view showing in further detail a typical pile driving hammer assembly together with a sheave arrangement and frame therefor;

Figs. 14 and 15 illustrate the manner in which the invention may be used for driving step-tapered pile shells, or shells the main part of which may be of an elongated unitary construction supplemented by step-tapered lower portions;

Fig. 16 is a sectional view of a joint construction and associated core parts which may be used in cases where it is desired to form the shell with a detachable screw connection at the middle, for example; and

Fig. 17 shows a modification of the boot construction of Fig. 11.

Referring now in further detail to the parts shown at the upper portions of Figs. 1 and 3–7 inclusive, a pile driving hammer assembly is indicated at 20 adapted to be slidably suspended at a variable height along the so-called "leads" or guideways of a pile driver, the suspending means comprising a pulley and cable as at 21. A so-called follower 22 is attached in a known way as by detachable sling means 23 to form the lower part of the hammer assembly. The core pulling means or "messenger plug" above referred to is shown in outline at 25 in Figs. 1–5 inclusive and in further detail by the perspective view of Fig. 10, as well as in Fig. 6. This

"messenger plug" may comprise a generally cylindrical main body portion as shown, the upper end 26 of which is preferably of square or other polygonal cross-section, adapted to be received in a socket portion 27 of like cross-section on the underside of the follower 22 (Fig. 6). Thus the "messenger plug," when its upper end is in this socket will be prevented from rotating, even though the equipment may be used with pile shells of a form as hereinafter described which have parts to be turned or rotated to secure same together or to bring the same into proper relationship with the driving core. A pair of sheaves as at 27*a*, 27*b* are mounted within the mid-portion of the "messenger plug," these being adapted to engage a four-part core lifting cable 28. As indicated in Figs. 10 and 10*a*, suitably shaped cavities 29 are provided in the body of the "messenger plug" 25, such that when the plug is in its uppermost position in engagement with the follower socket, the cable portions 28 will be spaced substantially below these sheaves. The sheave arrangement is so made, as will be further explained below, that the cable portions 28 will be spaced from the sheaves 27*a*, 27*b* at the moments of the driving impacts of the hammer, so that the cable will not have to be overhauled to any substantial degree (if at all) by reason of the hammer blows. It has been found that where a cable is directly attached to a core which is being driven, the force of the blow is materially reduced if it has to overhaul the plurality of parts of such cables. As further shown in Figs. 10 and 10*a*, the cavities at 29 are so shaped, however, that at times when the "messenger plug" is being suspended by the cables and is being used to raise the driving core, then the cables will be required to come up into positions to properly engage the grooves in these sheaves without escaping to the sides thereof.

As further shown in Fig. 10, the lower end of the "messenger plug" may be formed with a downwardly protruding portion 30 of reduced diameter, adapted to be received within an axially extending aperture 31 at the upper end of a shell driving core 32. The portion 30 may be detachably secured in the aperture 31 as by a cross pin 33 passing through apertures 34 in the walls of the core and through a slot 35 in the lower end of the "messenger plug." The pin 33 may be detachably retained in place when the messenger plug" is connected to the core by any suitable known means. As indicated at the bottom of Fig. 10, the lower end of the core 32 is provided with a plurality of lug formations, for example four, at spaced positions and adapted to be brought into engagement with lugs 35*a* on the shells as hereinafter explained.

Referring now to Figs. 5 to 7 inclusive, when the "messenger plug" is in its uppermost position, the parts of the cable 28 extend down and around two pairs of sheaves as at 37*a*, 37*b* and 38*a*, 38*b*, the cable portions extending straight and horizontally between these pairs of sheaves. However, when the "messenger plug" is at lower positions (for example as shown in Fig. 4) these cable portions will embrace the sheaves 27*a*, 27*b* and serve to support the plug and the core if attached thereto. And when, as shown in Fig. 4, the "messenger plug" is lowered to a position spaced substantially below the hammer, the cable portions will extend down over the sheaves as at 37*a*, 38*a* and thence inwardly down over two pairs of sheaves 39*a*, 40*b*, 41*a*, 41*b*, these latter sheaves serving to direct the cable portions ver-

tically down into the suspended shell as indicated at S in a manner such that the upper end edges of the shell will not contact the cable under pressure and cause abrasion thereof.

As best shown in Figs. 6, 7 and 9, the sheaves (other than those carried by the "messenger plug") are all mounted on a sheave frame **43**. As indicated in Fig. 9, this frame is vertically slidable on the leads or guideway members **44**, **45**, forming a part of the pile driver assembly. That is, a pair of "hammer extension members" **46**, **47**, having cross-sections like I-beams, are slidable along the inner faces of the leads and these members have bracket portions as at **48**, **49** extending outwardly therefrom (Fig. 6) to cross pieces as at **50**, **51**, between which suitable vertical plate members as at **52** are welded or otherwise secured, in which plate members the shafts from the sheaves are mounted. The cross members **50**, **51** are preferably detachably secured as by bolts as shown to the bracket members **48**, **49** so that these cross pieces and the parts of the assembly carried thereby may readily be removed to permit the hammer assembly to be slid down along the leads and thus off from the pile driver in cases where the construction is such that the hammer cannot be readily removed otherwise.

The sheave frame **43** as carried by the "hammer extension members" **46**, **47**, is slidably supported along the pile driver leads with the hammer assembly in the following way, as best illustrated in the example of Fig. 13 where one of the hammer extension members **47** is shown (partly broken away) as extending up from the sheave frame along to the top of the hammer assembly. The other hammer extension member **46** similarly extends up to the top of the hammer assembly and the two extensions are there interconnected in any suitable way, the connection resting upon a spring **53** supported on the upper end of the hammer assembly. As indicated in Fig. 8, the hammer extension members **46**, **47** may be interconnected and retained in proper position midway of their length by suitable yoke means **54**. The hammer assembly on striking succeeding impacts during its operation, is, of course, lowered in the usual way by the cable and sheave means **21** suitably controlled by the pile driver operator. Hence the sheave frame **43** as carried by the hammer extensions **46**, **47** (and resiliently supported on the spring **53** by the hammer assembly) will also be lowered step-by-step as the pile driving operation proceeds. At the same time the operator will control the cable **28** in a way similar to the usual control of the hammer supporting cable so that the sheave frame may be lowered with the hammer assembly without hindrance from the cable **28**.

When one of the elongated pile shells is in position ready for driving, a suitable boot means **55** as shown in Fig. 11 is first preferably applied to close off the lower end of the shell, thus rendering the whole shell watertight. This boot may comprise a rigid circular plate having a peripheral flange **55'** welded thereto and having threaded engagement with a "plow ring" **56** of conventional form, the latter in turn being welded at and within the lower end of the shell. An alternative form of boot construction is shown at **57** in Fig. 17 and with this form the peripheral flange is welded to a short section **58** of the helically corrugated tubular shell material, this short section being adapted to be screwed onto the lower end of the shell S as indicated.

The operation of the invention in so far as above disclosed will now be described more particularly with reference to Figs. 1–5. To start operations, a hole is made in the ground or preferably a tube or shell is first installed upright in the ground, having sufficient depth to receive the greater part of the driving core to be used. Conveniently such tube or shell may comprise a plurality of corrugated tubular pile shell sections of conventional type driven and attached to one another in succession in any suitable way. A first short shell section A' may be driven into the ground by the core **32** when placed therein. Thereby the core will be driven down to the position shown in Fig. 2, whereupon the "messenger plug" **25** is disconnected therefrom and the plug raised to a height sufficient to permit a second shell section A^2 to be suspended above the core **32** as by a manila rope, cable or other suitable sling means **60** operated by the hoisting means of the pile driver rig. Section A^2 is then lowered by sling **60** down about the core **32** to the position shown by dotted lines in Fig. 2 and there coupled to the shell section A'. Thereupon the "messenger plug" and hammer assembly are lowered enough to permit the core **32** to be used to drive the shell sections A' and A^2 down to a suitable depth. It will be readily apparent that the "messenger plug" can be raised and lowered for these various operations by pulling up or paying out the cable **28** under the control of the pile driver operator and the hoisting equipment available on the pile driver rig. Additional shell sections are successively driven in place in a similar way until the driven shell assembly is of sufficient depth to receive the greater part of the whole length of the driving core as indicated in Fig. 3.

With the sheave and "messenger plug" assemblies now in raised position as shown in Fig. 3, the sling means **60** is now used to suspend one of the unitary long shells S in aligned position above the core **32**, the lower end of the shell S being spaced far enough above the upper end of the core to permit the "messenger plug," when it is lowered, to be connected to the core. The "messenger plug" **25** is now lowered and connected by the pin **33** to the core **32**. Then the plug and attached core are raised to bring the core into "shelled-up" position. Boot means such as shown in Figs. 11 or 17 are now applied to the lower end of the shell. The shell may now be rotated to the extent necessary to bring the above-mentioned lugs **35***a* on the lower end of the core into superposed relation to complementary lugs as at **35'** formed on the inside of the plow ring **56** (or on the inside of the boot member in the case of Fig. 17) whereby the hammer impacts to be imparted to the core will in turn be imparted through the lugs and thus in effect pull the shell down into the earth during the driving operation.

After the core is "shelled-up" in suspended position on the pile driver as above described, the driving rig is ready to be moved to the location where the shell is to be driven. At that location the shell with the boot thereon and the core therein are lowered until the boot rests on the ground as indicated in Fig. 5, whereupon the core will push the messenger plug **25** up into seated position in the socket of the follower **22** and the driving operation is now proceeded with. When the shell S has been driven down to the desired depth, the core will, of course, be contained in the shell largely below the ground

level. The messenger plug may now be disconnected from the core and raised to the same position as shown in Fig. 3, whereupon another shell may be brought into suspended position and operations proceeded with in the same general way as above referred to. Thus it is unnecessary to move the pile driver back to and from the location where the initial "shelling up" operation occurred.

Of course in some locations the shells may be driven into earth submerged beneath a body of water in the same manner as above described, although in that case, of course, the surface of the water will be the equivalent of the "ground level."

It will be apparent that certain of the features of the method involved according to this invention might be carried out by "core pulling means," without the particular "messenger plug" arrangement above described. For example, instead of such plug, a cable might be dropped through the suspended shells and attached to the core to pull the core up into "shelled-up" position. In such a case the core could be hung from the base of the hammer by means of a sling or the like, but these operations would involve considerable loss of time, since the cable means or sling would have to be connected and disconnected for each "shelling up" operation and hence the above-described messenger plug and sheave arrangement is ordinarily preferred.

In Fig. 6 it will be noted that the surfaces of the sheaves as at 40*b*, 41*b* are shown with shallow peripheral grooves so as to be able to hold the cable as far in as possible to avoid the difficulty that would be caused by the flanges of the sheave rubbing against the core or messenger plug. Any such difficulties may generally be avoided if the core and plug are of appropriate diameters, but to avoid in some cases the use of an excessively small plug with consequent small sheaves therein, one may use a pivotal mounting for the lower sheaves on the sheave frame in the manner indicated at the lower part of Fig. 13. Here sheaves such as indicated at 65 are mounted on short pivoted links as at 66 arranged so that the links bear against stop means as at 67 when the plug and cable 23 are under tension, but when the plug is in its uppermost position, the sheaves 65 will be withdrawn from contact with the plug by springs as at 68.

Under certain circumstances and for some locations, it may be preferable to drive pile shells having a tapered point or lower end, of one form or another, instead of the completely straight-sided piles above referred to. The manner in which this may be accomplished by using a pile having a step-tapered lower portion is shown in Figs. 14 and 15. The first shell to be driven may be "shelled up" with its core in any desired special way, as explained above in reference to Fig. 1, and then the shell and core may be driven to the position shown in the lower part of Fig. 14. Then the messenger plug 25′ is disconnected from the core and the hammer and plug are raised to the position shown in the upper part of Fig. 14. A long, unitary, straight-sided shell S′ is then suspended as by sling 60′ as shown in the middle part of Fig. 14, the messenger plug being then lowered and connected again to the core, whereupon the plug is elevated to raise the core into "shelled-up" position. The driving rig is then swung to one side and a step-tapered shell ST (as shown in the lower part of Fig. 15) is dropped into the previously driven initial shell. The rig is then swung back, and, by hoisting means thereon, the step-tapered shell is raised and connected as by a screw joint means to the lower end of shell S′. With the connected shell parts then raised entirely above ground, the driving rig may be moved to the location where the shell assembly is to be driven, and the driving operations may proceed in a manner readily understood from the above descriptions of Figs. 1–5 and Fig. 14.

In some cases it may be preferred to use an elongated shell having a separable joint at the mid-portion as shown in Fig. 16. Here the upper shell portion 76 has a plow ring 71 at its lower end, with lugs as at 72 therein for engagement with lugs as at 73 formed on a core member 74. The plow ring may have threaded engagement with a stop ring 75 which has welded to its lower end a short section of helically corrugated tubular sheet metal 76 adapted to be screwed into the upper end of a lower shell portion 77. If desired the lugs 72, 73 may be omitted and then the driving impacts will be imparted from the portion 78 on the core to the shoulder provided by the stop ring 75. With some soil conditions it may be desirable to form the shell with several joints with plow rings as per the arrangement of Fig. 16.

In some cases the lower portion of the pile may be in the form of a pipe as at 33, connected in the manner shown in Fig. 12 to a plow ring such as shown in Fig. 16. Here a slip joint member 31 is provided with a threaded connection to the plow ring, as shown, the slip joint member having a depending sheet metal flange 32 into which the upper end of the pipe 36 telescopes up into contact with a core as at 32.

The invention may be utilized in connection with various types of cores other than those here illustrated, for example well known types of cores which are expansible to frictionally engage the shell walls, or of types such as disclosed in U. S. patent to Upson et al. No. 2,099,285. If such expansible types of cores are used, they may be pulled straight up into the shells without rotation. If cores such as of said Upson et al. patent are used, they are rotated either by hand or more or less automatically (as described in that patent) as they are pulled out of the shells, so that the lugs on the core will clear the lugs on the pile rings of the shell. Similarly preparatory to driving with cores such as of said Upson et al. patent, the shell is rotated by hand so as to engage the lugs on the shell with the lugs on the core.

With this invention for a typical case requiring an 80-foot pile, for example, a unitary shell or connected shell 80 feet in length would require a core also 80 feet in length, and about 15 feet of headroom would be required for the hammer, and another 8 or 10 feet for the "messenger plug." Thus no more than about a total of 105 feet of headroom is required in using this invention, as contrasted with 175 feet with the prior practice.

Although certain particular embodiments of the invention are herein disclosed for purposes of explanation, various further modifications thereof, after study of this specification, will be apparent to those skilled in the art to which the invention pertains. Reference should accordingly be had to the appended claims in determining the scope of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. In apparatus for "shelling up" pile shells

with a driving core and for driving such shells, the combination comprising: a pile driver having a pair of leads; a driving hammer assembly slidably mounted on said leads; a sheave frame beneath said assembly and suspended therefrom; a messenger plug having sheave means thereon and adapted to be suspended at varying elevations within said frame and therebelow along the vertical center line of the hammer, said plug also having means thereon for detachable connection with a pile shell driving core; and a plurality of sheaves on said frame at each side of said center line for directing cable means downwardly along the hammer assembly, thence from one side of said frame to the other side and back up along the hammer assembly, the messenger plug being suspendable at said varying elevations by such cable means coming into engagement with the sheave means on the plug, and whereby the plug may be lowered through a pile shell suspended thereunder, for connection with a core, and then raised to pull the core up into the shell.

2. In apparatus of the class described, frame means adapted to be suspended beneath the hammer and between the leads of a pile driver, vertically spaced sheaves carried by said frame means at each side of the position of the vertical center line of the hammer, a messenger plug movable vertically along such line within said frame and therebelow and adapted to receive hammer impacts at its upper end and formed with means at its lower end for detachable connection to a driving core for lifting such a core up into a pile shell when suspended beneath said frame, a plural part cable adapted to be engaged by the outer peripheral portions of the upper sheaves on said frame and to then pass downwardly and over the inner peripheral portions of the lower sheaves on the frame, said plug when lowered being suspended by generally parallel parts of the cable depending from said lower sheaves.

3. In apparatus of the class described, the combination comprising a pile driving hammer, a follower therefor having a socket on its underside, a messenger plug beneath said follower, the upper end of said plug being adapted to be received in said socket to thereby receive hammer impacts, the lower end of said plug being formed for detachable connection with a driving core, and means adjacent said follower for guiding a cable to suspend said plug and to lower and raise same through a pile shell when such a shell is in upright position below the follower.

4. In apparatus of the class described, the combination comprising a pile driving hammer assembly, a messenger plug below such assembly and adapted at its upper end to receive hammer impacts, the lower end of said plug being formed for detachable connection with a driving core, sheave means on said plug, and cable guiding means for guiding a cable to suspend said plug by said sheave means and to lower and raise the plug through a pile shell when such a shell is in upright position below said assembly.

5. In the driving of long pile shells within limited "headroom" by the use of a pile driver having hoisting means, leads, a hammer assembly, and a messenger plug capable of being raised and lowered through a pile shell positioned along such leads by a cable passing over sheaves mounted adjacent the hammer, the combination of method steps which comprises: placing a tube or the like in upright position with a substantial part below the ground level and with a pile shell driving core therein; utilizing the hoisting means to suspend a pile shell along the leads below the hammer assembly and above the upper end of such core; lowering the messenger plug through the shell and connecting such plug to the core; raising the plug to pull the core into "shelled up" position; moving the pile driver with the assembled shell and core thereon to the desired place for driving the shell; then driving the shell by impacts imparted by the hammer assembly through such plug to the core and thence to the shell; and then disconnecting the plug and core, the core in the thus driven shell being positioned to again be "shelled up" in like manner with the next shell to be driven.

6. In the driving of long pile shells by the use of a driving core therein, within limited "headroom" available for "shelling up" the core with the shells, the combination of method steps which comprises: starting with the core generally upright and largely below the ground level in a previously driven pile shell; suspending a shell above such core generally in alignment therewith; lowering a suspended core pulling means through such shell and connecting such means to the core; raising such means to pull the core into "shelled up" position; moving the suspended shell and core therein to the desired position for driving the shell; then driving the shell by impacts applied to the upper end of the core, the core in the thus driven shell being positioned to again be "shelled up" in like manner with the next shell to be driven.

7. In the driving of long pile shells by the use of a driving core therein, within limited "headroom" available for "shelling up" the core with the shells, the combination of method steps which comprises: starting with the core generally upright and largely below the ground level in a previously driven pile shell; suspending an upper separable portion of a pile shell above such core generally in alignment therewith; lowering a suspended core pulling means through such suspended shell portion and connecting such means to the core; raising such means to pull the core up into said suspended shell portion; lowering a lower shell portion into a previously driven pile shell; bringing said upper shell portion with the core therein into alignment with said lower shell portion and then bringing said shell portions together and connecting same in "shelled up" position about the core; and moving the "shelled up" assembly to the desired location for driving.

8. In the driving of long pile shells having a separable tapered lower portion, by the use of a driving core, within limited "headroom" available for "shelling up" the core with the shells, the combination of method steps which comprises: starting with the core generally upright and largely below the ground level in a previously driven pile shell; suspending a pile shell above such core generally in alignment therewith; lowering a suspended core pulling means through such suspended shell and connecting such means to the core; raising such means to pull the core up into said suspended shell; lowering the tapered lower shell portion into a previously driven pile shell; bringing said suspended shell with the core therein into alignment with said lower shell portion and then bringing said suspended shell and said lower portion together and connecting same in "shelled up" position about the core; and moving the "shelled up" assembly to the desired location for driving.

9. In apparatus of the class described, the combination of a pile driving hammer assembly, a messenger plug, the upper end of which is adapted to receive hammer impacts, and the lower end of which is formed with means for detachably connecting same to the upper end of a pile shell driving core, cable sheave means mounted in said plug intermediate its upper and lower ends, additional cable sheave means mounted adjacent the lower portion of the hammer assembly and adapted to guide cable parts from one side of the hammer center line into engagement with the sheave means on the messenger plug and thence to the other side of said center line as the messenger plug is being raised or lowered by the cable, said messenger plug being formed with a cut out portion beneath the sheave means thereon, permitting the cable to pass from one side of said center line to the other at a point spaced below the sheave means on the plug when the plug is applied to a core and thereby held up in impact-receiving position, and whereby transmission of hammer impacts to the cable is substantially avoided.

10. In apparatus of the class described, the combination of a pile driving hammer assembly, a messenger plug adapted for raising a shell driving core up into a suspended pile shell, the upper end of said plug being adapted to receive hammer impacts, and the lower end thereof being formed with means for detachably connecting same to the upper end of such a core, cable sheave means mounted in said plug intermediate its upper and lower ends, and additional cable sheave means mounted adjacent the lower portion of the hammer assembly and adapted to guide cable parts from one side of the hammer center line into engagement with the sheave means on the messenger plug and thence to the other side of

said center line as the messenger plug is being raised or lowered in a pile shell by the cable.

11. In apparatus of the class described, the combination comprising: a pile driving hammer assembly; a sheave frame means; hammer extensions extending down from said hammer assembly and resilient means cooperating therewith for resiliently supporting said frame; and sheave means on said frame for guiding a cable for raising a pile driving core up into a pile shell when suspended beneath such frame.

12. In apparatus of the class described, the combination comprising: a pile driving hammer assembly; a sheave frame means; hammer extensions extending down from said hammer assembly slidably along the hammer leads for supporting said frame; and sheave means on said frame for guiding a cable for raising a pile driving core up into a pile shell when suspended beneath such frame.

13. In the driving of long pile shells which are to be closed at their lower ends by boots, by the use of a pile driving rig having limited "headroom," the combination of method steps which comprises: placing a pile shell driving core in a previously driven pile shell or the like; suspending the pile shell to be driven in upright position above the upper end of such core; suspending core pulling means through the latter shell and connecting such means to the core; raising such means to pull the core up into the latter shell; applying a boot to the lower end of the latter shell and moving such shell with the core therein to the desired position for driving; and then driving the shell by impacts applied through the medium of the core.

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No references cited.