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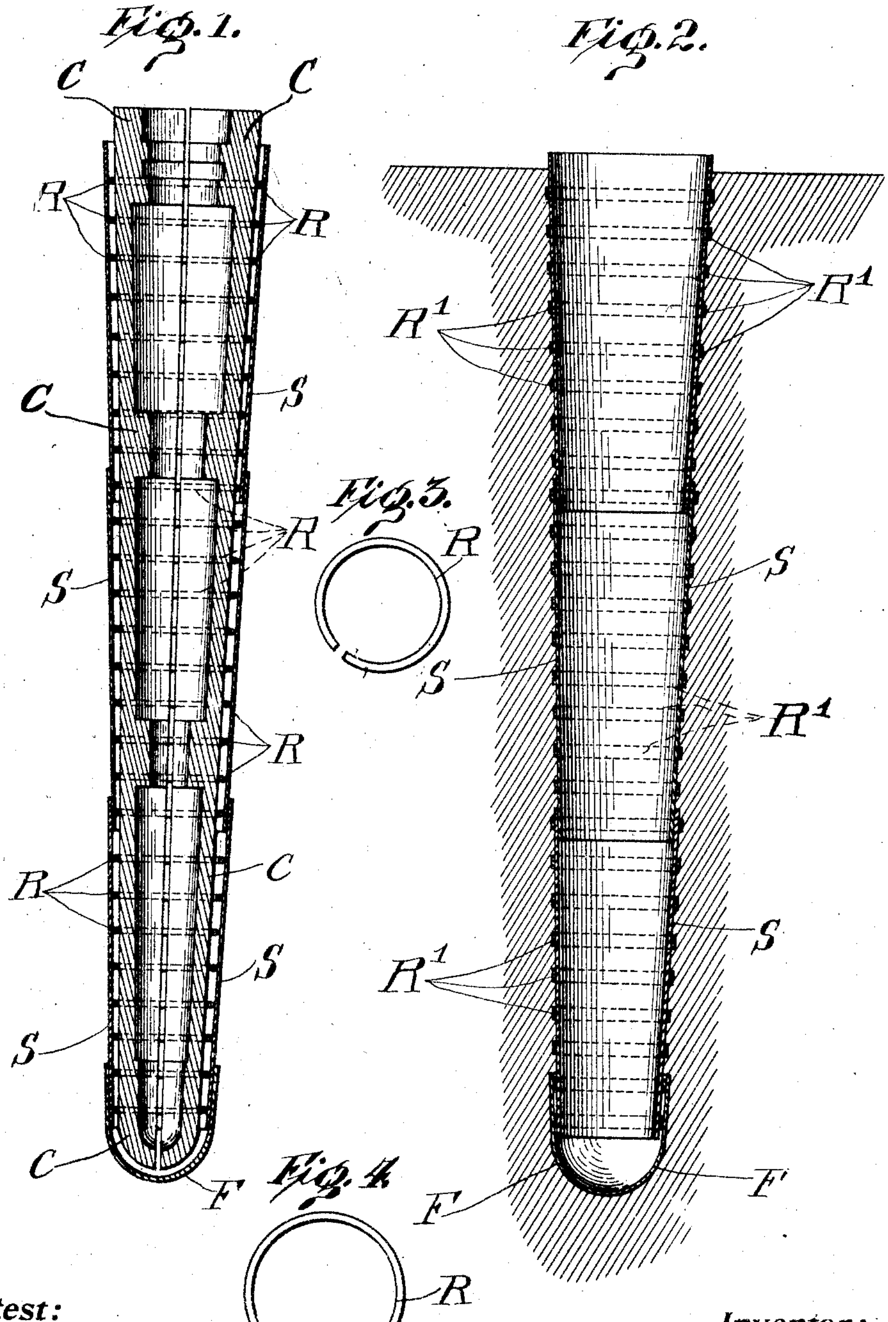
SHELL FOR MOLDING CONCRETE PILES.

APPLICATION FILED OCT. 12, 1909.

991,121. Patented May 2, 1911.



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by Philip Farnsworth Atty

UNITED STATES PATENT OFFICE.

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SHELL FOR MOLDING CONCRETE PILES.

991,121. Specification of Letters Patent. Patented May 2, 1911

Application filed October 12, 1909. Serial No. 522,302.

To all whom it may concern:

Be it known that I, ELIHU D. WATT, a citizen of the United States of America, and a resident of the town of La Grange, State of Illinois, have invented certain new and useful Improvements in Shells for Molding Concrete Piles, the principles of which are set forth in the following specification and accompanying drawing, which disclose the form of the invention which I now consider to be the best of the various forms in which the principles of the invention may be embodied.

This invention relates to improvements in the construction of molds or pile-shells for concrete piles, such shells being adapted for employment in the molding of piles in place in accordance with such methods as those disclosed in United States Letters Patent to Raymond, Nos. 589,026 and 806,838, whether or not the shell be left in the ground as a permanent part of the pile, and particularly when the shell is driven or sunk into the ground, and remains there prior to being filled with concrete, as, for example, and especially, when the driving core of the first specified patent is withdrawn, or in some cases, when the outer pipe of the last-mentioned patent is withdrawn prior to filling the inner shell with concrete. In brief, the invention is applicable to all cases of molding a concrete pile *in situ* where a shell is used as a mold for the concrete, whether such mold-shell be temporary for the purpose of molding, or permanent for use both as a mold and a permanent part of the concrete pile installation.

The object of the invention is a pile-shell constructed or arranged to withstand the strains to which it is subjected under the above-specified unfilled, earth-surrounded condition, all within the limits of practical economy; and the invention consists of such a shell constructed and arranged for such object, and in substance as illustrated by the disclosures herein of exemplification embodiments such as those shown in the accompanying drawings, of which—

Figure 1 is a vertical section showing a shell on the core ready for driving, Fig. 2 a vertical section of the shell grounded and ready to receive the concrete, and showing one of the various modifications of the invention; Figs. 3, and 4 are plans of a reinforcing member showing steps in the process of its manufacture.

The core may be of any suitable construction, such as the three plates C (two only being permissibly shown in the section Fig. 1), to be moved in and out respectively by a suitable wedged interior spindle not shown; or as the expansible and collapsible core of United States Letters Patent No. 777,351; or the core need not be employed when the shell is equivalently grounded, as, for example, in the disclosure of the above-specified Patent No. 806,838.

The shell S, and the core when used and fitting inside the shell, are preferably but not necessarily tapering, or frusto-conical, as shown, in order not only to facilitate driving but also to increase the load-carrying capacity of the ultimate concrete pile. The shell or shell-sections may be withdrawn after the soft concrete has been placed in it, and preferably before the concrete sets; but the present practice is to leave it in the ground to serve as a permanent pile-covering, and, in an upper water stratum, as a coffer-dam. Generally, a rounded "point" or footing F is provided to close the bottom of the shell, as shown, this being preferably hollow and of thin material like the main shell-part, as shown, and in such case, and generally, constituting a permanent part of the concrete pile.

The shell is thin, being made of thin sheet-metal such as steel, or of paper, the material in any case being liable to collapse by external earth pressure when grounded, on account of the thinness of the shell-wall, adopted from considerations of economy in respect of the small mass of expensive material, particularly when, as in the present practice, the shell is of steel and constitutes a permanent part of the pile and is therefore lost to use as a mold for other piles. The function of the shell is merely to maintain the shape of the hole formed by the driving core, during the interval between the time the core is withdrawn and the hole filled with concrete and until the concrete sets to a degree sufficient to withstand the earth pressure. This earth-pressure occurs not only as the result of the act of driving, but is also liable to be increased very greatly by the adjacent driving of other piles before the concrete sets in a pile first molded.

Since the shell fits tightly over the core during driving, it is then subjected to no serious strains, and it need have only sufficient strength to oppose the pressure of external earth tending to collapse it.

The shell usually consists of sections, preferably horizontal as shown, as in Patent No. 700,707. If desired, the shell may consist of a single part, or if sectional, the sections may be vertical, with vertical overlaps, as for the purpose of more ready removal, section by section, after the introduction and before the setting of the concrete, in cases where the shell is not to be a permanent part of the pile. The shell, or a shell section, may be formed preliminarily from sheet material in any desired manner, such as by the winding machine of United States Letters Patent No. 848,394, or of 848,851. The overlapping vertical edges may be welded or riveted together. After the shell or its sections are formed from the sheet material, and completed in accordance with the invention, and ready for use, the core, in expanded condition, is elevated by the pile-driver, and the shell or shell-sections are drawn up over the expanded core as shown in Fig. 1. Each section may overlap the section next above it, as shown, or an upper section may overlap a lower section.

The thin sheet-metal shell so far described is practicable only for cases where the pressure of external earth is not sufficient to collapse the thin material. The material and strength of the shell have their nearest analogue in a common stove-pipe, although the shell is somewhat stronger than that. Obviously, it is necessary to prevent such collapse, because that would prevent the molding of a pile of the designed dimensions and strength. It has been the practice, therefore, to do the obvious thing in cases of great earth-pressure, *i. e.*, to use a heavier shell, which means that thin material was entirely discarded, and a thick heavy frusto-cone used in its place. Notwithstanding that various attempts have been made, as a result of the great expense of such heavy shells, to produce a cheaper shell of equal or sufficient strength, the object seemed impossible of accomplishment owing to the difficulties encountered under the peculiar conditions involved, not only in construction, but in the use of the shell, driven into the earth, as a mold for concrete piles.

In accordance with the preferred practice in pursuance of this invention, each thin shell, or shell-section, is provided, preferably on its interior, with reinforcing means, which, like the shell, is of quite small mass, and which is non-integral with the shell, *i. e.*, does not comprise parts formed by any special configuration of the shell itself; and such non-integral reinforcing means is so constructed, and said means and the thin shell are so combined, as not only to prevent the collapsing of the shell under inward pressure of external earth, but to cause a material reduction in cost as compared with the heavy shells heretofore necessary to be used for like conditions.

I have found that it is not necessary to increase the thickness of the shell throughout its length, but that the material of the ordinary extremely thin sheet-steel shell is sufficiently strong to permit use in cases of maximum earth-pressure, provided only that the area of such material, otherwise unsupported, is not too great. Considerable difficulty has attended the practical solution of this problem, on account of the peculiar conditions involved in the use of the shell for its purpose of molding concrete piles, including not only the earth-conditions outside the shell, but also the varying conditions inside the shell, such as the expansion, driving, collapsing and withdrawal of the driving core; which are hereinafter referred to in greater detail in connection with the construction and arrangement of the reinforcing means. The reinforcing means constituting the practical solution of the problem comprises simply a plurality of metallic rings R, Figs. 1 and 4, proportioned as to diameter in conformity with the diameter of the shell so as to fit against its surface and be permissibly located at suitable distances apart, and inserted in the shell prior to the drawing up of the shell over the expanded core C; so that, prior to the commencement of the driving operation, the combination has the relations shown in Fig. 1, wherein the rings R are located between the core and the shell. These rings, when properly constructed and combined as more particularly described hereinafter, have been demonstrated to act to prevent collapse by external earth pressure as efficiently as a uniformly thick, heavy and more expansive shell, notwithstanding that even when they are applied to a thin shell, they are separated from each other by intervals of considerable length. That is to say, the construction and combination is such that the rings serve to reinforce not only the particular points of the shell at which they may be respectively located, but they coöperate with the thin shell-material extending across the interval between rings, in such way as to also reinforce all other points of the shell. The distance apart of the reinforcing rods or rings is determined by the area of thin sheet-metal between them which it is practicable, under given conditions, to leave unsupported.

The rings R are preferably of metal such as steel or iron, or, if desired, of any other material suitable for reinforcement. They may have a circular section as in Fig. 1, or the section may be oblong as in Fig. 2 for a special purpose. When of circular section,

and in case of average high-pressure earth conditions and of combination with the standard thin shell, they may be a quarter inch in diameter and located along the wall of the shell about three inches apart. A determination of the various lengths of the respective rings having been made for a given case, as for a tapered shell of given proportions and a given requirement as to distance apart, the rods are cut to such length, and each bent, as around a former, to as nearly annular form as possible, as shown in Fig. 3. Thereupon the abutting free ends are welded together as indicated at W, Fig. 4, preferably in pursuance of the art of electric welding. When properly done, this produces a substantially perfect annulus adapted to fit tightly the wall of the shell and be readily and firmly adjusted to its particular intended place of seating prior to the drawing up of the shell over the driving core. This result of efficient and simple location is important because it saves the cost of securing the rings to the shell as by riveting, welding, etc. Furthermore, owing to the joining together of the ends of the ring, the ring is self-reinforcing, and each ring is a complete self-contained reinforcing means acting by itself independently of any other ring. This arrangement of reinforcing means consisting of the distribution of separate complete units is also important, in connection with the permissible lack of means securing the rings to the shell, in that it simplifies the operation of collapsing and withdrawing the core after grounding has been effected. When the reinforcing means consists of a single structure not divided into separate units, it is liable to be pulled up by the core, at least to an extent sufficient to permit a serious collapse of the shell. But when the rings R, as separate units, are employed, the danger of such an occurrence is greatly reduced, even when the rings are not positively secured to the shell.

If desired, the rings R, or any other form of reinforcing rod or wire, etc., may be riveted or welded to the shell; and the reinforcing means may consist of separate units other than rings, or may consist of a single unitary structure. The welding of the rings, (or other forms), to the shell, or other securing, such as riveting, may be resorted to in any case wherein the separate rings (or other forms), not connected to anything, either each other or the shell, might not be best on account of fortuitous conditions, as in case the rings showed a tendency to be withdrawn by the core, in cases such as special uses of the interior location of Fig. 1. The interior location of the rings, shown in Fig. 1, is adapted for use in the practice of leaving the shell in the ground as a permanent part of the pile.

In Fig. 2, the rings R^1 are oblong in section, in order to reduce resistance to earth during driving, such reduction being desirable in case of the exterior location of the rings shown. This exterior location of rings is advantageous in that the rings are independent of the operations of the core inside the shell. Although located on the outside of the shell, they act very efficiently as reinforcements, as they can be fitted tight around the shell, and the downward driving operation of the tapered shell insures their maintenance in that most efficient reinforcing condition, so that when the core is withdrawn, the rings are certain to be in their best positions, ready to assume their duty of resisting collapsing strains the instant the core is withdrawn. The outside location of the rings is also particularly adapted for the practice of removing the shell after it has served its primary function as a mold for the concrete; because the outside rings have no engagement with concrete inside the shell. The butt-welding of the rings R, R^1 is desirable more particularly in the case where the reinforcing means is not applied until after the shell itself has been completed.

As an alternative method of producing the reinforcement of this invention, the reinforcing means, such as rods suitably disposed, is applied to the thin metal sheet prior to the rolling or winding thereof to form the shell. In view of all the above, it will be evident that rods may be welded or riveted to the sheet, so that when the sheet and rods are wound, the rods may take an annular form and their free ends may abut, to operate as in the case of butt-welded rings inserted in a completed shell. This example is referred to as an indication of the many various ways in which the invention may be produced, as well as the various different forms it may assume.

The construction comprising the plurality of rings shown, constitutes not only a reinforcing means which amply resists strains of external earth tending to collapse the thin shell, but is a structure which is much more economically produced than the structures heretofore used for similar conditions, such as the heavy-gage shells used in cases where the external earth pressure was so great as to collapse the thin shells ordinarily used as where the earth pressure is very slight.

In this invention, while the cost of the plurality of rings is considerable, yet that cost, with the addition of the cost of properly combining them with the shells, is much less than that of the thick, heavy shells heretofore used.

The data and dimensions specified herein will of course be varied for different conditions, and the rings may be of various materials and forms, and need not be completely annular, and need not be separate

rings as distinguished from a helical or spiral-helical rod; and the rods or wires R may have any desired location or direction of location on the surface of the shell. Also the construction of the shell itself may be modified as desired. All such and similar matters are left to the designer for special conditions. The word "rod" is used generically in the claims to include all forms of reinforcement within the invention.

It will be clear from the above that when the core C, collapsed, is withdrawn up from within the grounded shell, but before the concrete is placed in the shell, the structure of this invention provides ample resistance to collapsing strains, and that said structure is one combining the advantages of simplicity and economy with that of efficiency. The reinforcing means insures against collapse due to earth pressure caused not only by the act of driving the shell itself, but by the driving of adjacent shells at any time before the concrete has set in a shell first sunk.

This invention relates specifically to reinforcements which are not integral with, *i. e.*, do not consist of parts of, the shell itself, that is to say, although they may be secured to the shell, yet they do not consist of or reside in any special reinforcing configuration of the material of the shell itself. But the invention is generic as to all non-integral reinforcements.

I claim:

1. The combination with a pile-shell of collapsibly thin sheet-metal for molding concrete piles in place in the ground, of a plurality of butt-welded metal rings arranged along the interior wall of the sheet-metal of the shell and operating when the shell is grounded, to oppose pressure of external earth tending to collapse the thin sheet-metal of the shell.

2. The combination with a pile-shell of collapsibly thin sheet metal for molding concrete piles in place in the ground, of a plurality of bent metal rods arranged along the interior wall of the sheet-metal of the shell and operating when the shell is grounded, to oppose pressure of external earth tending to collapse the thin sheet-metal of the shell.

3. The combination with a pile-shell of collapsibly thin sheet-metal for molding concrete piles in place in the ground, of a plurality of bent metal rods arranged along the sheet metal wall of the shell and operating when the shell is grounded, to oppose pressure of surrounding earth tending to collapse the thin sheet metal of the shell.

4. The combination with a pile-shell of collapsibly thin sheet-metal for molding concrete piles in place in the ground, of a metal rod arranged along the sheet-metal wall of the shell and operating when the shell is grounded, to oppose the pressure of surrounding earth tending to collapse the thin sheet-metal of the shell.

5. The combination with a pile-shell of collapsibly thin sheet-metal for molding concrete piles in place in the ground, of a plurality of butt-welded metal rings arranged along the wall of the shell and operating, when the shell is grounded, to resist pressure of surrounding earth tending to collapse the thin sheet-metal of the shell.

6. The combination with a pile-shell of collapsibly thin sheet-metal for molding concrete piles in place in the ground, of a plurality of bent metal rods secured to the wall of the shell and operating when the shell is grounded, to resist pressure of surrounding earth tending to collapse the thin sheet-metal of the shell.

7. The combination with a pile-shell of collapsibly thin sheet metal for molding concrete piles in place in the ground, of a metal rod secured to the shell and operating, when the shell is grounded, to resist pressure of surrounding earth tending to collapse the thin sheet-metal of the shell.

8. The combination with a tapered pile-shell of collapsible thin sheet-metal for molding concrete piles in place in the ground, of a plurality of metal rings having diameters graded to the taper of the shell and arranged along the sheet-metal wall thereof, and operating, when the shell is grounded, to resist pressure of surrounding earth tending to collapse the thin sheet-metal of the shell.

9. The combination with a tapered pile-shell of collapsibly thin sheet-metal for molding concrete piles in place in the ground, of a plurality of metal rings having diameters respectively graded to the taper of the shell and arranged along the interior wall of the sheet-metal shell, and operating, when the shell is grounded, to oppose pressure of external earth tending to collapse the thin sheet-metal of the shell.

10. The combination with a pile-shell of collapsibly thin material for molding concrete piles in place in the ground, of a plurality of rings arranged along the wall of the shell and operating, when the shell is grounded, to oppose pressure of surrounding earth tending to collapse the thin material of the shell.

11. The combination with a pile-shell of collapsibly thin material for molding concrete piles in place in the ground, of a rod secured to the interior wall of the shell and resisting pressure of external earth tending to collapse the thin material of the shell.

12. The combination with a pile-shell of collapsibly thin material for molding concrete piles in place in the ground, of means non-integral with the shell and arranged along the wall thereof to operate, when the shell is grounded, to resist pressure of sur-

rounding earth tending to collapse the thin material of the shell.

13. The combination with a pile-shell of collapsibly thin material for molding concrete piles in place in the ground, of a rod supported against the wall of the shell and operating, when the shell is grounded, to resist inward pressure of surrounding earth tending to collapse the thin material of the shell.

14. The combination with a pile-shell of collapsibly thin material for molding concrete piles in place in the ground, of a plurality of rings supported against the interior wall of the shell and reinforcing it, when grounded, against pressure of external earth tending to collapse the thin material of the shell.

15. The combination with a pile-shell of collapsibly thin material for molding concrete piles in place in the ground, of reinforcing members secured to the shell and arranged to resist inward pressure of earth surrounding the shell when grounded, and tending to collapse the thin material of the shell.

16. The combination with a pile-shell of collapsibly thin material for molding concrete piles in place in the ground, of reinforcing rings supported by the shell and arranged to resist inward pressure of earth surrounding the shell when grounded and tending to collapse the thin material of the shell.

17. The combination with a pile-shell of collapsibly thin material for molding concrete piles in place in the ground, of reinforcing rings secured to the shell and arranged to resist inward pressure of earth surrounding the shell when grounded and tending to collapse the thin material of the shell.

18. The combination with a tapered pile-shell of collapsibly thin material for molding concrete piles in place in the ground, of reinforcing rings supported by the shell within the tapered portion thereof and operating, when the shell is grounded, to resist pressure of external earth tending to collapse the thin material of the shell.

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Witnesses:
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