Feb. 8, 1955 E. M. YOUNG 2,701,449

COMPOSITE PILE

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FIG. 1.

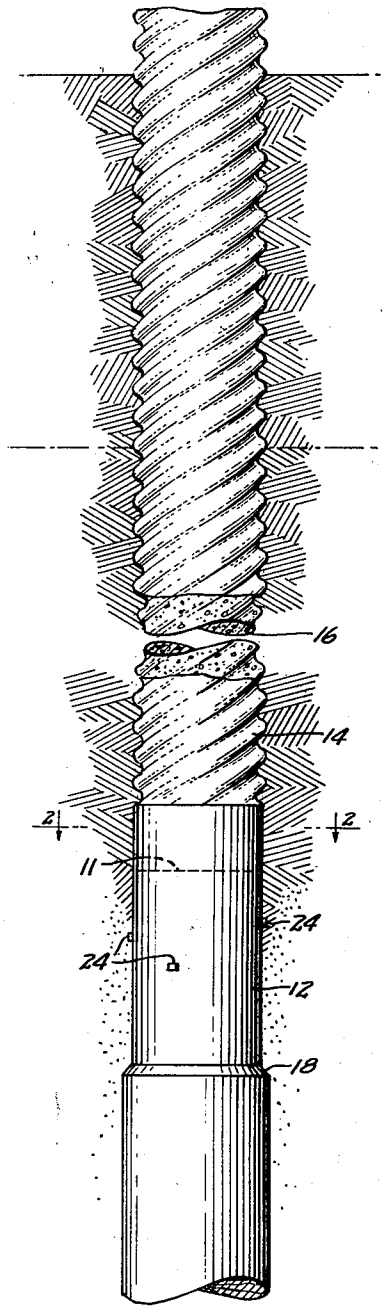


FIG. 2.

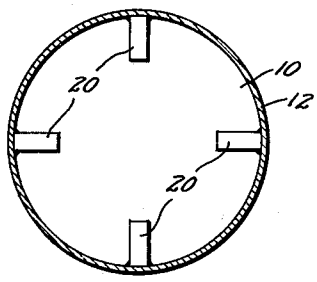
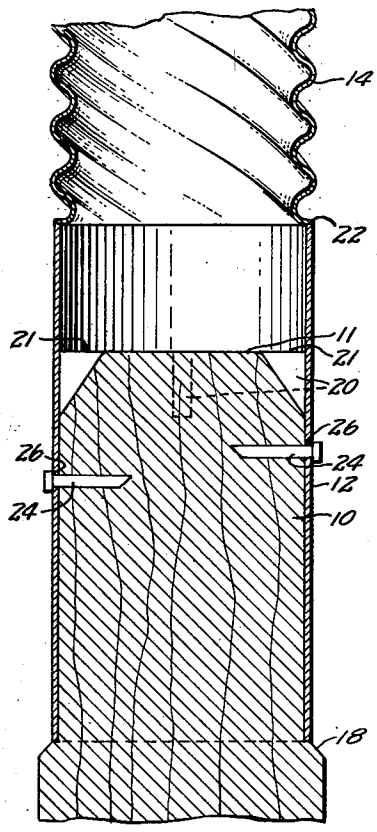


FIG. 3.



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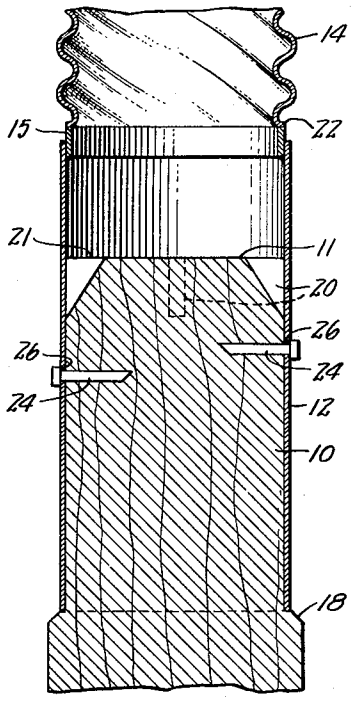
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FIG. 4.



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COMPOSITE PILE

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6 Claims. (Cl. 61—53)

This invention relates to improvements in piling, and particularly to an improved composite pile of the type formed partly of wood, partly of metal, and partly of concrete.

Piles are used to support or to form foundations for structures such as buildings, tanks, bridges, conduits, piers, wharves, etc., by inserting them into or through the yielding surface strata far enough to obtain a solid support for the principal structure.

As is well known, untreated wooden piles are frequently unsatisfactory when exposed to salt or brackish water, or when exposed to changing tides or changing water tables. In free water such piles are attacked by marine borers, Teredo and Limnoria and are subject to rot. In earth above the lowest level of the water table they are subject to termites, fungi, mold and rot. Because concrete is not unduly affected by the above destructive forces, it has been proposed to use a composite wood-concrete pile structure having a wooden section entirely below the area where the above destructive forces attack and a concrete section connected to the top of the wooden section.

One of the problems in composite piling of this type is that of providing a strong joint between the wood and concrete sections. This is important because a piling may be subjected to lateral and tension forces as well as compressional forces. For example, in locations where the strata immediately adjacent this joint provide insufficient lateral support, as where the joint area is surrounded by shifting silt or water, it is not uncommon for the pile to fail at the wood-concrete junction. It is one object of the present invention to provide an improved composite pile structure having high resistance to lateral stresses.

In the construction of subsurface storage tanks, tensional stresses will develop on supporting piling if the tank is partially below a shifting water table and is only partly filled so that the surrounding water tends to float the tank. It is, accordingly, another object of this invention to provide an improved composite pile that is especially well adapted to withstand both tensional and compressional longitudinal forces as well as lateral stresses.

Another trouble with composite pile construction has been the difficulty of driving the pile. If the pile is preassembled, its weight makes it difficult to handle and its length may make it difficult or impossible to drive. Moreover, the concrete is subjected to the successive impacts of the driving tool and may shatter or fracture in the driving operation. Although various arrangements have been proposed for casting the concrete portion in situ above a previously driven wooden section, none of the proposed methods that gives a sufficiently rugged and reliable structure are cheap enough to be used. For example, concrete cannot be poured above the pile until it has been driven to its final depth, because it would be necessary to wait for the concrete to set before completing the driving operation. Long piles must be driven in one substantially continuous operation; once they have become "set," it is difficult or impossible to again start the pile moving. It is, accordingly, a further object of the invention to provide an improved composite pile that can be readily assembled and driven and which has high structural strength.

In summary, it can be stated that although various solutions for the individual problems mentioned above have been proposed, they are not sufficient to produce

entirely satisfactory composite piles. In the first place, unless a particular solution results in a pile that is low enough in cost—there is no solution to the problem; a pile that is prohibitive in cost simply cannot be used. Thus, piling that requires special metal parts which must be machined or cast do not provide any useful solution. Moreover, it is no solution to the over-all problem to provide an answer to one particular phase of the problem in one construction, and an answer to another phase of the problem in another structure; every phase of the problem must be solved in one composite structure.

In accordance with the present invention, a composite pile is provided which fulfills the requirements set forth above, and which is economical in use and which does not require expensive or scarce specially-fabricated parts. In an embodiment of the invention to be described later, a smooth-walled sleeve is joined to a corrugated shell and driven with a driving fit onto the upper portion of a wooden pile by means of lugs projecting radially inwardly from the inner surface of the sleeve. These lugs provide shoulders for receiving the driving impacts from a driving mandrel lowered into the casing formed by the shell and sleeve, the sleeve being driven onto the wood pile to the depth of the lugs so that the lugs are embedded in the upper end of the wooden member. If desired, anchoring means can be inserted laterally through holes in the sleeve to extend into the wood to increase the tensional strength of the pile. When the wooden pile with the casing superposed has been driven to the desired depth, the mandrel is withdrawn and the casing is filled with concrete.

A more complete understanding of the invention can be had by reference to the following description of an illustrative embodiment considered together with the accompanying drawing, in which:

Figure 1 is a longitudinal elevation of a completed composite pile embodying the invention;

Figure 2 is a sectional end view of the pile of Figure 1 taken along the line **2—2** of Figure 1;

Figure 3 is an enlarged cross sectional view of the wood-concrete joint area of the pile structure of Figure 1; and

Figure 4 is a view similar to Figure 3 showing an alternative way of securing the parts of the structure.

Referring to Figure 1 of the drawing, a pile constructed in accordance with the invention can be seen to comprise two principal parts: a wooden lower section **10** (the lower part of which is not shown) and an upper concrete-filled casing section formed of a smooth-walled sleeve **12** joined to and forming a continuation of a corrugated sheet-metal shell **14**.

The wooden section **10** ordinarily will be generally circular in cross-section, such as a section of log, although, unlike other known structures, the cross-sectional shape of the wooden section is not of particular importance. In other words, no preshaping of the wood is required, the only requirement being that the cross section of the upper portion thereof be slightly larger than the inside diameter of the sleeve **12**, as will be more fully explained presently. It is also preferable, although not essential, that the cross-sectional dimensions of the wooden section **10** exceed the outside diameter of the sleeve **12**.

The sleeve **12** is formed of a length of steel pipe or the like, say, twelve inches in diameter with walls ¼ inch thick. The pipe **12** may have any desired length, but its length must be at least equal to its maximum diameter or it will not provide the necessary resistance to lateral forces. Thus, if the outside diameter of the pipe is twelve inches, it must be at least twelve inches long. A length of two to three feet is preferred for most applications. The inside diameter of the sleeve **12** is required to be slightly smaller than the cross section of the upper part of the wooden member **10** so that the sleeve **12** can be driven down onto the wooden member **10**, shearing off the upper end of the wooden section, usually leaving the main part of the wooden section slightly larger than the sleeve **12** as indicated in the drawing by the shoulder **18**. This secures a tight fit between the wood and the sleeve; a factor which contributes to the

stress-resisting features of the pile presently being described.

A still tighter fit between the wood 10 and the sleeve 12 is had near the upper end of the sleeve, where (see Figures 2 and 3) a plurality of lugs 20 project radially inwardly from the inner surface of the sleeve 12. These lugs 20 preferably are wedge-shaped, as shown, tapering outwardly and upwardly with the widest portion being at the top to form flat shoulders 21 facing toward the junction of the sleeve 12 and the shell 14. The shoulders 21 are equidistant from and a short distance below the junction of the sleeve and the shell, the shoulders 21 thus being in a common plane substantially at right angles to the casing axis, providing a multipoint support inside the casing for a pile-driver mandrel (not shown) which is lowered into the casing for driving the pile, as will be explained later.

When the pile is completely assembled, the lugs 20 will be embedded in the upper end of the wooden section 10, with the shoulders 21 flush with the upper end 11. This causes some displacement of the wood to provide an extremely snug fit between wood and sleeve adjacent the lugs. The wedge shape is preferred for the lugs, both to make it easier for the lugs to enter the wood and to provide a gradual rather than a sudden transition in the snugness of the fit between the wood and the sleeve.

The increased snugness provided by the lugs 20 is a material factor in developing both tensional and lateral stress resistance.

The shell portion 14 of the casing is joined to the sleeve 12 in any suitable manner. Preferably, as shown in the drawing, the shell 14 is merely welded as at 22 to the upper end of the sleeve 12. Alternatively, a collar 15 slightly smaller than the inside diameter of the sleeve 12 can be welded to the end of the shell 14 and then welded to the inside surface of the sleeve 12, as shown in Figure 4.

As already suggested, the shell 14 preferably is corrugated in helical or spiral turns. For certain particular conditions of use a horizontally-corrugated or smooth cylindrical shell can be used. Helical corrugations are preferred as they contribute to the lateral rigidity of the casing. However, it is not necessary that the shell 14 be as rugged as the other parts of the pile, since the mode of assembly and placement of the pile puts very little strain on this shell portion 14. For example, a suitable shell has been found to be a 16 or 18 gauge (U. S.) corrugated sheet-metal cylinder, sold under the trade name "Armco." If desired, the shell 14 may be provided with vertical flutes; it may be tapered; and any desired anchoring or reinforcing means can be used.

In assembling and placing the composite pile, the wooden section 10 first is driven with a pile driver in the usual way until its upper end 11 is just above the surface of the soil or water, as the case may be. The assembled upper casing parts 12 and 14 then are placed in position on top of the partially driven wooden section 10, and a suitable mandrel (not shown) is lowered into the casing until it rests on the shoulders 21 provided by the lugs 20. The pile driver then is used to drive the sleeve 12 down over the upper portion of the wooden section 10, shearing off a layer of material from this upper portion of the wooden member, and thereby fitting the sleeve 12 snugly onto the wood. It is to be noted that the entire strain of this driving operation is transferred by the lugs 20 to the sleeve 12, so that the shell 14 simply is drawn down with the sleeve as the latter is driven onto the wood. The comparatively thick-walled sleeve 12 is fully capable of withstanding the impact force imparted by the pile driver to the follower, so that no potentially damaging forces are applied to the relatively weaker and more readily collapsible corrugated shell.

Additional protection of the shell will be afforded by having the wooden member 10 slightly larger in cross section than the casing 12, 14. With this arrangement, the wooden portion will provide a hole large enough to receive the casing with a minimum of frictional and/or tensional stress on the shell.

The driving operation is continued, with the shell moving downwardly over the wooden section to the depth of the lugs 20, the shoulders 21 eventually becoming flush with the upper end 11 of the wooden member 10. In entering the wood, the lugs will expand the upper end of the wooden member slightly, ensuring an extra tight fit adjacent the lugs.

Under most conditions of use, this structure will be more than sufficiently resistant to tensional stresses. However, if it is anticipated that the piling will be subjected to abnormal tensional stresses, additional locking of the parts can be obtained with locking elements 24 added to the assembly. For example, dock spikes, lag screws, or the like can be inserted laterally through holes 26 in the sleeve and embedded in the wood 10.

Continued driving force applied to the assembly will force the parts down to the desired final location. Thereupon, the driving mandrel will be withdrawn and the casing 12, 14 filled with concrete 16 to complete the construction.

It will be noted that the sleeve 12 has the additional useful function of protecting the upper end 11 of the wooden member 10 against splitting, "dubbing over," or otherwise being damaged by the severe driving impacts.

It can be seen that the composite pile assembly just described has a number of distinct advantages. From the standpoint of strength and rigidity, the tightly fitting sleeve and wooden sections, 12, 10, while being simple to handle and assemble, have been found to provide exceptional structural strength.

Moreover, the structural strength of the present pile is attained without the use of concrete reinforcing members, preshaped wooden sections, or special pile driving apparatus such as collapsible followers or the like. In fact, only a few readily obtainable and easily handled parts are required—the wooden section 10, the sleeve 12, the lugs 20 and the shell 14. If desired, the upper casing parts 12, 14, 20 may be assembled at the construction site, by welding the parts together as needed.

Further, it is noted that the present pile structure involves no bulky and unwieldly precast concrete sections, which entail the additional disadvantage that they must be set aside for several days of "curing" before they can be used. Nor does the present pile structure involve temporary casings that must be withdrawn after the pile is in position—a troublesome and time consuming operation.

Accordingly, it is apparent that the present invention provides a simple yet rugged composite pile structure and mode of assembly thereof that is economical and is adapted to be used in a wide variety of constructional applications.

What is claimed is:

1. A composite pile comprising a lower wooden section, a substantially cylindrical upper casing of cross section slightly smaller than that of said wooden section, said casing comprising a tubular shell and a smooth-walled sleeve joined to said shell to form a continuation thereof, a plurality of lugs on the inner surface of said sleeve, the upper surfaces of said lugs being in a common plane substantially at right angles to the axis of said casing, said sleeve extending around the upper portion of said wooden section to the depth of said lugs and having a snug, driving fit over said wooden section with said lugs embedded in said wooden section, and a filling of concrete in said casing above said wooden section.

2. In a composite pile, a lower wooden section, an upper casing section comprising a corrugated shell portion and a smooth-walled sleeve joined to the lower end of said shell, a plurality of wedge-shaped lugs projecting radially inwardly from the inner surface of said sleeve with the widest part of each said lug forming a shoulder on said inner surface facing toward the junction of said shell and said sleeve, said sleeve extending over the upper portion of said wooden section and having a driving fit thereon, said lugs being embedded in said wooden section so that said shoulders are flush with the upper end thereof, and a filling of concrete in said casing above said wooden section.

3. A composite pile comprising a lower wooden section, an intermediate sleeve section slightly smaller in diameter than said wooden section and having a driving fit about the upper portion of said wooden section, a plurality of lug members projecting radially inwardly from the inner surface of said sleeve near the upper end thereof at uniformly spaced points about said inner surface and embedded in said wood, said lugs having flat upper surfaces at right angles to the axis of said sleeve and flush with the upper end of said wooden section providing cooperating shoulders facing upwardly in said sleeve to present a multipoint support for a driving member lowered into said sleeve, a generally cylindrical sheet-metal shell welded to the upper end of said sleeve and extending up-

wardly therefrom, and a filling of concrete in said sleeve and said shell above said wooden section.

4. A composite pile comprising a lower wooden section, a substantially cylindrical upper casing of cross-section slightly smaller than that of said wooden section, said casing comprising a helically corrugated shell and a smooth-walled sleeve forming a continuation of said shell, a plurality of lugs projecting radially inwardly from the inner surface of said sleeve at points substantially equidistant from and relatively close to the junction of said shell and said sleeve, the upper surfaces of said lugs lying in a common plane extending at right angles to the axis of said sleeve, said sleeve extending around and forming a driving fit on said wooden section with said lugs embedded in the upper end of said wooden section, and a filling of concrete in said casing above said wooden section.

5. A composite pile comprising a lower wooden section, a substantially cylindrical upper casing of cross-section slightly smaller than that of said wooden section, said casing comprising a helically corrugated shell and a smooth-walled sleeve welded thereto, a plurality of wedge-shaped lugs on the inner surface of said sleeve with the widest part of each said lug forming a shoulder on said inner surface facing toward the junction of said shell and said sleeve for transferring driving impact force from a pile driver member lowered into said casing to the walls of said sleeve, said lugs being located at points substantially equidistant from and relatively close to the

junction of said shell and said sleeve, the upper surfaces of said lugs lying in a common plane, said sleeve extending around and forming a driving fit over said wooden section with said lugs embedded in said wooden section, said sleeve having in its walls a plurality of holes, locking elements driven through said holes into said wooden section, and a filling of concrete in said casing above said wooden section.

6. A composite pile comprising a lower wooden section, a substantially cylindrical casing of cross section slightly smaller than that of said wooden section, said casing comprising a corrugated upper shell portion and a smooth-walled sleeve joined to the lower end of said shell to form a continuation thereof, a plurality of lugs on the inner surface of said sleeve providing on said inner surface a plurality of supporting shoulders in a common plane at right angles to the axis of said casing and facing upwardly therein to receive driving impact from a pile driver member lowered into said casing, said sleeve extending around and forming a driving fit with the upper portion of said wooden section, said lugs being embedded in the upper end of said wooden section, and a concrete filling in said casing above said wooden section.

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