MANDREL FOR DRIVING PILE SHELLS

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The present invention relates to apparatus for driving metal casings, usually called shells, into the earth for receiving concrete to form concrete piles, and contemplates an im-

proved expandable and collapseable mandrel for driving corrigated shells.

The invention particularly is concerned with mandrels of the type having an inner mandrel part or member sur-

rounded by an outer mandrel member comprising a plu-

rality of longitudinally segmented exterior leaves which can be expanded and contracted by the inner mandrel member.

One feature of the mandrel of the invention is that it has a plurality of transversely-extending rod segments se-

cured to the outside of the leaves and disposed in spaced relation with respect to the longitudinal axis of the man-

drel. These rod segments have utility when used in driv-

ing shells having corrugations in that the rods, being ar-

ranged to extend across the corrugations at small acute angles, become partially embedded in the corrugations of the shell when the leaves are expanded in the driving of the shell to provide a good driving engagement between the mandrel and the shell. When the mandrel is used in driving shells or casings having helical corrugations, the rods are attached to the leaves substantially at right angles to the longitudinal axis of the mandrel so that the rods of the mandrel and corrugations of the shell do not coincide with one another but rather lie at an angle to one another. This assures that the rods will bite into por-

tions of the corrugations when the outer mandrel mem-

ber leaves are expanded and form a good driving enga-

gement between the mandrel and the casing shell. This ar-

rangement not only overcomes the tendency of the man-

drel to move relative to the shell and tear the corrup-

gations causing expensive delays, but also facilitates driv-

ing shells under severe conditions. It also compensates for variations in the shell.

Another feature of the present mandrel is that the driving head is mounted on the driving head stem by a 

universal ball and socket arrangement forming a universal joint. To this end, the upper portion of the stem termi-

nates in a hemispherical or ball portion which movably engages or rests in a hemispherical socket centered at the bottom of the driving head. Prior driving heads, in being integrally mounted on the driving head stem, fre-

quently fail by a shearing of the stem immediately under-

lying the head. By mounting the driving head mov-

ably on the stem, failures of the stem during the driving operation are minimized, if not entirely eliminated. In

addition, this mounting permits the driving head to rock with respect to the stem to adjust itself on the outer man-

drel member leaves to rest equally on all leaves, thereby

transmitting the driving force directly and equally from the head to all the leaves and thereby to the shell with-

out affecting the head stem.

The present mandrel also includes a driving shoe for engaging the bottom of the shell during the driving oper-

ation, the shoe being attached to a cross-bolt or pin pass-

ing through the hollow inner mandrel member by a wire

rope or cable. Prior driving shoes have been attached to such a bolt or pin by a steel strap. In practice, this strap, being free to vibrate during driving, frequently failed by shearing at the driving shoe. By attaching the shoe to the inner mandrel member with a flexible member, such as wire rope or chains, which is not subject to having vi-

brations set up in it during the driving operation; these failures are minimized, if not entirely eliminated.

The invention is applicable generally to mandrels hav-
ing expansible and collapseable segments or leaves, and

for the purpose of illustration will be described in con-

nection with a mandrel embodying features of the mandrel

of my copending application Serial No. 642,418, filed

February 26, 1957, now Patent No. 2,977,770, of which

this application is a continuation-in-part.

The invention will be further described in connection

with the accompanying drawings, in which

FIG. 1 is a vertical sectional view, partly in elevation, of a mandrel embodying the invention and shown in its fully contracted or collapsed position; FIG. 2 is a vertical sectional view similar to FIG. 1, but showing the mandrel in its fully expanded position; FIG. 3 is an enlarged cross-sectional view, taken on line 3—3 of FIG. 1, showing the mandrel in its collapsed position; FIG. 4 is a view similar to FIG. 3, but taken on line 4—4 of FIG. 2, showing the mandrel in its fully expanded position; FIG. 5 is an enlarged vertical sectional view, partly in elevation, of a portion of the mandrel in its fully expanded position showing the rods securely engaging the shell; and

FIG. 6 is a vertical sectional view similar to FIG. 1, but showing the mandrel in an intermediate position.

The improved mandrel of the invention comprises an inner mandrel member 1 and an outer mandrel member 2. The inner mandrel member is a continuous tube. The outer mandrel member comprises three arcuate sec-

ions or leaves 3, 4 and 5 which in the expanded position form a circular assemblage that fits inside the pile shell casing 8, as shown in FIG. 4. A driving stem 6 is slidably received in the upper portion of the inner man-

drel member. The stem terminates at its upper end in a machined hemispherical or ball portion 7. A driving head 8, which receives the driving blows of the hammer, has a machined hemispherical socket 9 which re-

ceives the ball portion 7, forming a ball-and-socket or uni-

versal joint. This joint provides sufficient freedom of movement between head 8 and stem 6 to allow the head to swivel on the driving stem and to adjust itself during the driving operation to rest equally on the upper ends of all of the outer mandrel member leaves, thereby equalizing the driving force imparted to the leaves. A cover plate 11 extends over the opening in the driving head in which the ball portion 7 is received. This plate protects the universal joint from foreign matter and from damage during the driving operation. The cover plate may be secured to the driving head in any manner, as for example, by a circumferential weld.

The inner mandrel member 1 has upper and lower bosses 12 and 13 which have downwardly and inwardly sloping wedge surfaces 14 and 16, respectively, which cooperate with upper and lower wedge segments 17 and 18 on the inner surfaces of the leaves 3, 4 and 5 of the outer mandrel member and have inwardly and downwardly sloping surfaces 20 and 21, respectively. Any suitable number of such bosses and wedge segments may be provided at longitudinally spaced intervals on the inner mandrel member and the outer mandrel member leaves. At the beginning of a driving operation, the wedge surfaces 14 and 16 bear against sloping surfaces 20 and 21, respectively, to expand the leaves to bring their outer surfaces into driving engagement with the casing shell.

The inner mandrel member 1 has a plurality of stag-

gered longitudinally-extending, circumferentially-spaced slots 22 between each pair of bosses. Beneath each slot,
the inner mandrel member is enlarged to provide a wedge segment 23 having an upwardly and outwardly extending wedge surface 24. Cam brackets 26, extending from the inner surface of the leaves, project through the slots 22 and have a wedge surface 27 engaging the corresponding wedge surface 24 of the inner mandrel member. When the inner mandrel member is raised, the wedge surfaces 24 bear against and exert a wedging action on cooperating wedge surfaces 27 carried on cam brackets 26. This wedging action forces the cam brackets and their attached leaves inwardly to bring the leaves to their collapsed position, also shown in FIG. 1. The cam brackets 26 extend downwardly inside the hollow inner mandrel member a distance such that when the mandrel is inserted in the pile shell and the inner mandrel member is moved to extend the leaves outwardly the maximum distance, the free or distal ends of the cam brackets still lie below the lower ends of the slots and opposite a portion of the wall of the inner mandrel member, so that the leaves are held to the inner mandrel member.

To facilitate the collapsing of the leaves of the outer mandrel member after a driving operation, as hereinafter more fully described, and to connect the driving stem to the inner and outer mandrel members, the upper portion of the inner mandrel member 1 has three longitudinally-extending slots 28 staggered longitudinally and circumferentially, one opposite each leaf. The leaves of the outer mandrel member each have a slot 29 opposite one of slots 28. A floating cam lever 31 is positioned in each set of the slots. The outer part of each cam lever projects through the elongated, longitudinally-extending slot 29 in the adjacent leaf of the outer mandrel member. The intermediate portion of each cam lever lies in the slot 28 in the inner mandrel member. The inner part of each cam lever projects into an opening or slot 32 in the driving stem 6. The cam levers 31 are referred to as "floating" since they are not mounted on pins but are free to move to a limited extent, relative to the stem 6, the inner mandrel member, and the leaves of the outer mandrel member.

The upper portion of the mandrel is provided with a loose fitting collar 33 which is suspended from hammer cables C. This collar is the means by which the mandrel is manipulated into and out of the shell. Since the collar hangs loose during the driving operation, the mandrel is free to rotate with the shell, which tends to turn or to be threaded into the earth, due to its helical corrugations, without twisting the cables which support the collar.

The inside diameter of the collar is only slightly greater than the outside diameter of the outer mandrel member when the leaves are in their expanded position. Thus, the collar lies sufficiently close to the outer edges of the cam levers 31 to prevent them from falling out of the slots 28, 29 and 32 in which they are mounted. This eliminates the necessity of pins for mounting the collar, which is desirable since the pins tend to shear under the forces to which they are subjected.

At intervals spaced in the longitudinal direction of the mandrel axis a plurality of integral, elongated, rigid, rod-like projections 34 are attached, as by welding, to the exterior surface of the leaves 3, 4 and 5 of the outer mandrel member. These rod-like projections may be of any suitable cross-sectional shape, such as round or half-round, and may be spaced a distance corresponding to the distance between adjacent corrugations of the shells. When shells having helical corrugations are to be driven, such as illustrated in the drawings, the projections are arranged at approximately right angles to the longitudinal axis of the mandrel. As thus arranged, the projections are disposed at an acute angle with respect to the corrugations. Therefore, when they are in engagement with the shell, they extend across the corrugations thereof. It is to be understood that when the corrugations of the shell are not helical, as for example, at right angles to the longitudinal axis of the shell, the projections are then so angularly attached to the leaves that they form acute angles with respect to the corrugations. When the leaves of the outer mandrel member are moved outwardly under the expansive force exerted by the inner mandrel member, these projections become partially embedded in the corrugations and form a secure driving engagement.

When the mandrel is fully inserted in the shell, its lower end will engage the closed lower end 36 of the shell. As shown in FIG. 1, the lower end of the inner mandrel member 1 terminates in an outwardly-extending boss 37 having a downwardly and inwardly sloping wedge surface 38. This wedge surface cooperates with the downwardly and inwardly sloping wedge segments 42 extending inwardly at the lower end portion of each of the leaves of the outer mandrel member. The wedge surface 38 cooperates with the wedge surfaces 41 to force the leaves of the outer mandrel member outwardly, similar to the manner in which wedge surfaces 14 and 16 of bosses 12 and 13 cooperate with wedge surfaces 20 and 21 of wedge segments 17 and 18.

A pin or bolt 43 extends crosswise of the inner mandrel member a short distance above the boss 37. A wire rope 44 is looped to form an eye surrounding pin 43. Both ends of the wire rope pass through the lower end of the outer mandrel member and are secured to a driving shoe 46 which engages the bottom of the casing during a driving operation. The ends of the wire rope are secured to the driving shoe by passing them through a central opening or bore 47 in the driving shoe and anchoring them in an outwardly-flaring lower portion of the opening as by a filling of weld or solder metal or otherwise, as indicated at 48. Since the wire rope attaching the driving shoe to the mandrel is flexible, the driving blows applied to the mandrel will not set up vibrations in it causing eventual failure of the attachment. In order to keep wire rope 44 from entangling itself, when it is forced outwardly, the first few driving blows delivered to driving head 8 will be transmitted from the bottom of
the head to the top of the inner mandrel member causing wedge surfaces 14, 16 and 38 to wedge segments 17, 18 and 42 of the leaves outwardly still more, forcing the leaves into close contact with the casing shell S. When the leaves have been fully expanded in the shell, the top of the inner mandrel member lies in the same horizontal plane as the tops of the outer mandrel member leaves. In this position, the driving head B bears on the top of all the leaves and the top of the inner mandrel member while the rod-like projections 34 are forced against the corrugations of the shell by the wedging action of the inner mandrel member wedging surfaces 14, 16 and 38 on the outer mandrel member wedging surfaces 20, 21 and 41 during driving, as shown in Figs. 2 and 5, and by reason of their angular relation to the corrugations, and bite into or become partially embedded in those portions of the corrugations with which they make direct contact, thereby providing a good driving connection between the mandrel and the casing shell. Since the projections are spaced laterally and longitudinally about the mandrel and engage portions of the corrugations of the shell throughout its length and circumference, the force of the driving blows is transmitted to the shell in a relatively uniform fashion throughout its length and circumference. This means that a minimum of strain will be exerted on any one part of the shell thereby insuring, insofar as is possible, that the shell will not tear but remain in one piece during the driving operation. During the driving operation shoe 46 will be held against and reinforce the bottom 36 of the shell by the bottom of the leaves of the outer mandrel member.

When the shell has been completely driven, and the mandrel is to be removed, an upward pull is applied by the hammer cables C on the collar 33 and by the collar on the driving head 8. In the initial upward movement of the driving head, cam levers 31 come into action in collapsing the leaves of the outer mandrel member. In this initial action, the cam levers perform three important functions, namely, their outer ends hold the leaves of the outer mandrel member down, their intermediate portions engage the tops of the slots 28, raising the inner mandrel member and breaking the contact of the leaves of the outer mandrel member with the inner mandrel member which were bound by the force of the pile hammer, and their inner ends lock the stem 6 of the driving head to the inner mandrel member. That is, as the inner mandrel member is pulled slightly upwardly, the inner end of each cam lever engages the bottom of slot 32 while the intermediate portion of the upper surface of the cam lever contacts the upper portion of the slot 28 of the inner mandrel member. As the stem 6 is further withdrawn, the outer end of each lever bears down on the lower end of the leaf slots 29, while the intermediate portion of the upper surface of the cam lever bears on the upper portion of the slot 28 of the inner mandrel member and lifts it sufficiently to break the contact between the inclined surfaces of the leaves of the outer mandrel member and the inner mandrel member. As stem 6 is further withdrawn, the cam levers lock against the inner mandrel member 1 and stop the sliding action of the stem therein. As the inner mandrel member continues to move upwardly, the surfaces 14 and 16 move out of contact with the surfaces 20 and 21, as shown in Fig. 1, and the surfaces 24 move upwardly above the surfaces 27 of the brackets 26 to pull the leaves inwardly to the position shown in Fig. 1, thereby freeing the mandrel from engagement with the shell and permitting the mandrel to be removed by further upward pull on cables C.

Various changes may be made in the details of construction of the mandrel herein described without departing from the invention or sacrificing any of the advantages thereof, the scope of the invention being set forth in the appended claims.

1. A mandrel for driving pile shells comprising an inner mandrel member and an outer mandrel member including a plurality of expandable and collapsible rigid leaves, the inner mandrel member being hollow at least at its lower end, a pin extending transversely through said hollow lower end of the inner mandrel, a driving shoe, a wire rope having a looped portion passing around said pin and having its ends attached to said shoe, and a rigid guide sleeve surrounding said rope between said shoe and said looped portion of the rope.

2. In combination with a pile shell having circumferentially extending corrugations, a mandrel for driving said pile shell, said mandrel having a plurality of expandable and collapsible rigid leaves extending in the longitudinal direction thereof, an inner mandrel member for expanding and collapsing the leaves, each leaf having a plurality of integral, elongated, rigid, rod-like projections extending outwardly from its exterior surface and extending circumferentially thereof, said projections being relatively long, of relatively small cross-sectional area and disposed at an acute angle with respect to the corrugations of the pipe shell, the projections extending crosswise of the corrugations of the pile shell at an acute angle and being partially embedded in said corrugations.

3. The combination set forth in claim 2 in which the mandrel includes a driving head, a driving stem, and a universal joint connecting said head to said stem.

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