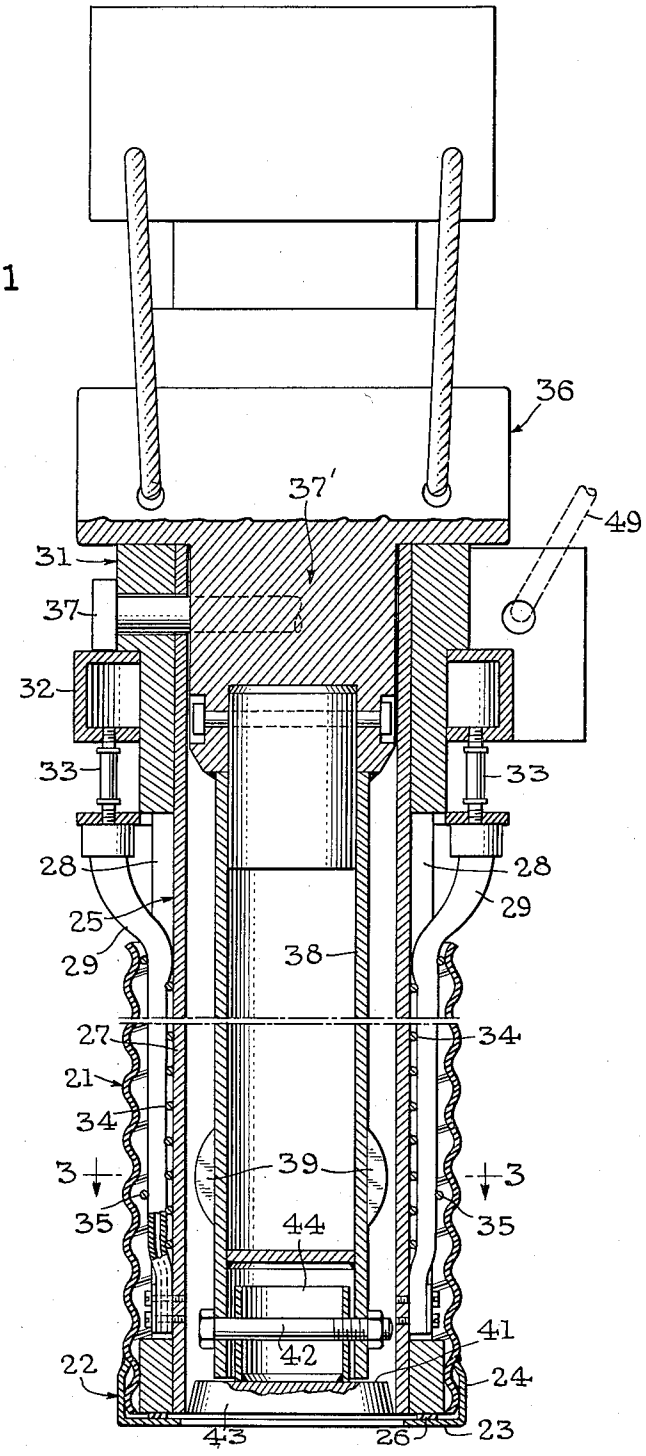
Oct. 24, 1961 W. H. COBI 3,005,315

PILE FORMING APPARATUS AND METHOD

Filed July 15, 1958 3 Sheets-Sheet 1

Fig. 1



PILE FORMING APPARATUS AND METHOD

Filed July 15, 1958 3 Sheets-Sheet 2

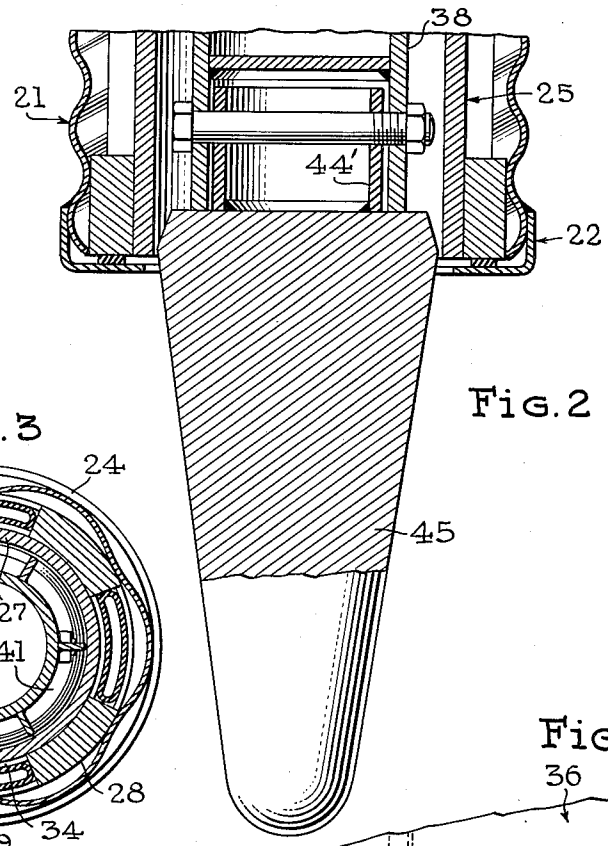


Fig. 2

Fig. 3

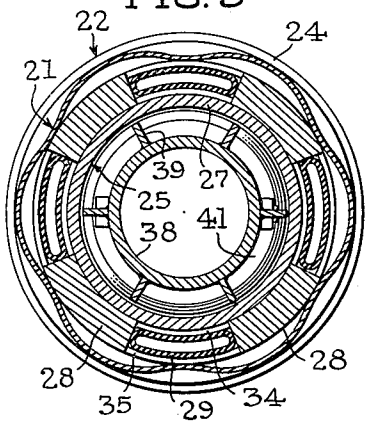


Fig. 4

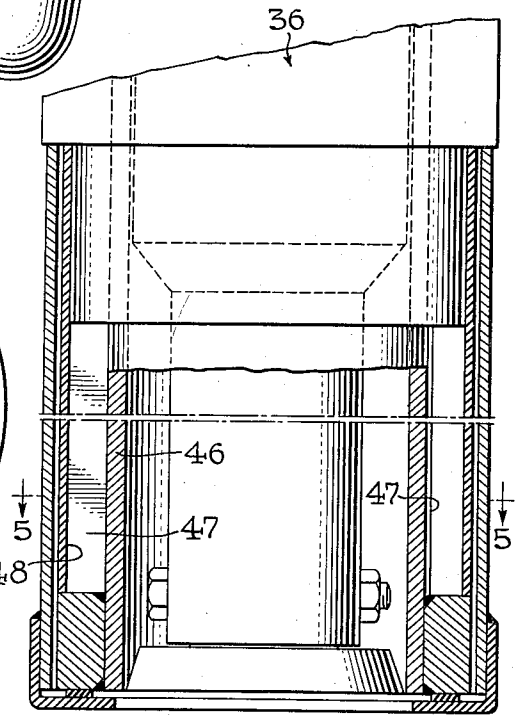
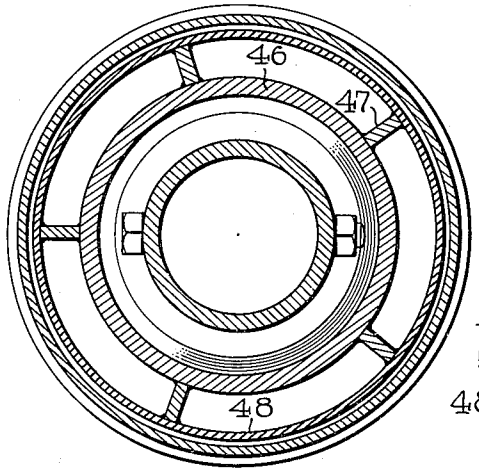


Fig. 5



PILE FORMING APPARATUS AND METHOD

Filed July 15, 1958 3 Sheets-Sheet 3

Fig.6

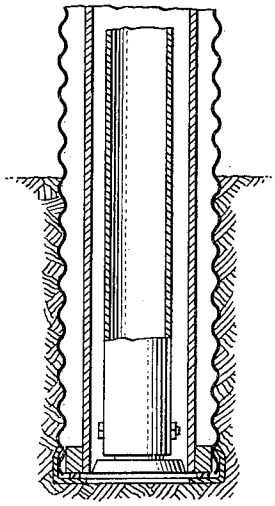


Fig.7

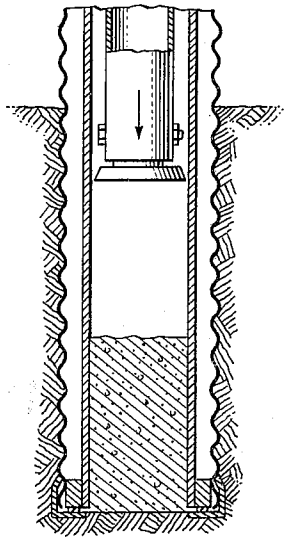


Fig.8

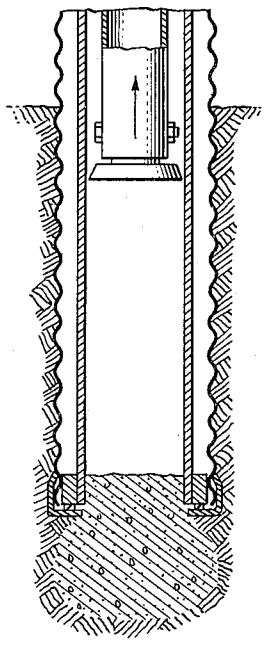
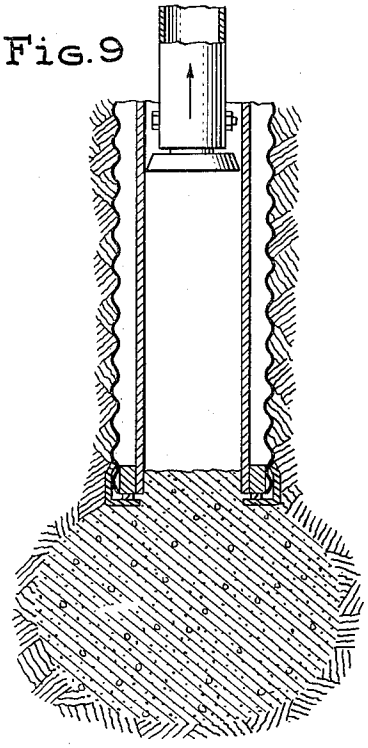


Fig.9



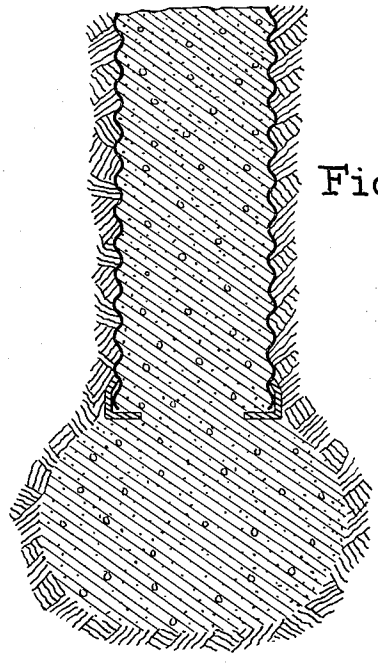


Fig.10

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3,005,315

PILE FORMING APPARATUS AND METHOD

Walter H. Cobi, 45 Upland St., Port Chester, N.Y.

Filed July 15, 1958, Ser. No. 748,699
7 Claims. (Cl. 61—53.72)

This invention relates to apparatus for constructing cast-in-place concrete piles. Particularly, it relates to casting "ball" or "bulb" piles, i.e., a cast-in-place pile having a generally spherical enlargement at its lower end.

Ball piles are commercially known and find particular use in footing or foundation structures. In many localities it would be necessary, in order to reach adequate support against intolerable settling, to use conventional piling of extreme length. Such piling is uneconomical, both because of its extreme length and the time required to form the pile. Under such conditions, it has been proposed to use ball piles. A ball pile, because of its large bearing area, can be adequately supported in a soil stratum which would provide inadequate support for a conventional pile. Use of such piles can result in considerable savings, both in time and expense.

In conventional uncased cast-in-place piling, it is impossible to inspect the pile after it has been placed. It is essential that ball piles be formed which have shafts of relatively uniform diameter and with a ball which is properly shaped, i.e., spherical and centered on the vertical axis of the shaft.

It has been proposed to form ball piles in two basically different ways. In one case a tubular pipe, closed at its lower end by a plug of relatively dry concrete, is driven to the desired depth. Concrete is dumped into the pipe in small amounts and tamped so as to expel the plug and permit the additional concrete to be forced out and form the spherical enlargement or ball. After a ball of adequate size is formed, the pipe is withdrawn step by step and additional concrete added and tamped to form the shaft of the pile. The resulting pile has no metal casing and there is no way to insure that its shaft has a uniform area or even an area which is at least no smaller than a prescribed minimum. The second method is to drive a capped tubular casing to the desired depth. The casing is then secured against further movement and the cap forced or broken off so as to permit concrete to be rammed into place to form the necessary ball enlargement. The casing is then filled. This second method is generally preferable to the first, since the casing, which is left in place, insures a shaft of uniform diameter. However, the cap (used to close the lower end of the casing while it is being driven) sometimes assumes a position after removal which hinders uniform expansion of the ball and a faulty pile may result.

The present invention is similar to the second of the described methods, but is characterized by the fact that the closure for the lower end of the casing is not forced off into the soil stratum at which the ball is formed.

The preferred embodiment of apparatus embodying this invention comprises a tubular mandrel within a thin shell which will form the casing of the pile to be cast. This mandrel comprises a heavy-walled pipe which serves to support and guide the relatively thin shell. An annular sealing means reacts between the lower end of the casing and the lower end of the mandrel tube. The upper end of the mandrel tube engages the driving head of the hammer and, during the setting of the shell, is securely fastened to an extension of said driving head.

An inner plunger member, removable from the upper end of the shell, extends downward through the mandrel pipe and carries at its lower end a closure member which fits the mandrel pipe adjacent the lower end thereof. This closure member may take different forms, depending upon the character of the subsoil at the bottom of the pile shell.

The preferred embodiment of the invention will be described having reference to the accompanying drawings, in which:

FIG. 1 is an axial cross-section of the pile shell, mandrel and ram preparatory to driving the pile shell.

FIG. 2 is a fragmentary axial section of the shell, mandrel and ram, but equipped with a closure different from the one shown in FIG. 1.

FIG. 3 is a sectional view on line 3—3 of FIG. 1.

FIG. 4 is a fragmentary axial section, similar to FIG. 1, but showing another type of mandrel.

FIG. 5 is a sectional view on line 5—5 of FIG. 4.

FIGS. 6, 7, 8, 9 and 10 are diagrammatic showings of the pile in different stages of completion.

Refer first to FIG. 1. This figure shows the apparatus arranged to drive the casing into place. Reference numeral **21** indicates the relatively thin-walled, corrugated casing or shell which is to be driven into place. At its lower end, the casing **21** carries a boot **22**. The boot **22** includes an annular flange **23** which extends radially inward and partially closes the end of the casing **21**. It also includes an upstanding collar **24** welded to casing **21**, as shown. Extending downward through the casing is a hollow mandrel **25** whose lower end engages flange **23** against which it seals. A suitable mastic material or gasket **26** provides this seal.

Referring to FIG. 3, it will be seen that the mandrel **25** includes a relatively heavy-walled tube **27**. Connected in alternation around the tube **27** and extending substantially its entire length are a series of arcuate spacers **28** and inflatable bags **29**. A header **31** encircles the upper end of the mandrel tube **27** and abuts the upper ends of spacers **28**. A manifold **32** surrounds the header **31** and is connected by flexible connectors **33** to the upper end of each of the bags **29**. A series of rods **34** extend between spacers **28**. These rods are welded at their ends to spacers **28** and to the outer surface of the mandrel tube **27**. A second series of rods **35** extend between spacers **28** and serve to retain the bags **29** in place between the spacers **28**. The rods **35** are spaced further apart than rods **34**. This mandrel assembly, with the exception of the boot **22** and seal **26**, is essentially the same as the mandrel described and claimed in applicant's copending application Serial No. 551,678, filed December 7, 1955.

A hammer anvil **36** is secured to the header **31** and the mandrel tube **27** by means of a bolt **37**. This bolt **37** may be removed for reasons which will be hereinafter explained.

Anvil **36** includes a cylindrical projection **37'** fitted into the upper end of mandrel tube **27**. A tubular ram **38** is guided in the mandrel tube **27** and is attached to the anvil **36** and its projection **37'**, as shown. In FIG. 1, a series of circumferentially spaced radially extending guides **39** are shown. There may be several sets of these

guides 39, the number depending upon the length of the ram 38 which they support against buckling.

A closure member 41 is secured to the lower end of ram 38 by means of a bolt 42. As shown in FIG. 1, this closure comprises a plate 43, whose outer periphery fits tube 27, and a cylindrical connector flange 44.

An alternate form of closure is shown in FIG. 2 and comprises a connector flange 44' and a conoidal projection 45 whose base is secured to the flange 44' and whose axis is aligned with the axis of the ram 38.

An alternate form of mandrel is shown in FIGS. 4 and 5. It includes an inner tubular member 46 mounted on the anvil 36 in the same manner as tube 27. Tubular member 46 has a series of longitudinal ribs 47 mounted on its outer surface which carry a thin-walled tube 48 which is coaxial with tubular member 46. It should be noted in this embodiment that tube 48 engages the casing without any intermediate inflatable means. Instead of using a tube 48, a series of thin, relatively flexible curved plates, independent of one another could be carried by ribs 47.

The operation of the apparatus will first be described having reference to FIGS. 1 and 3. The casing 21 is raised upright, and the mandrel 25 and the ram 38, connected together by bolt 37, are lowered into it. Pressure fluid is then admitted into bags 29 whereby the casing 21 is securely held in place on the mandrel 25. The mandrel 25, casing 21 and ram 38 are then driven (see FIG. 6) into the ground to the desired depth. This depth will ordinarily be determined by test drillings made previously. After the casing is driven, the bolt 37 is removed and the casing 21 and the mandrel 25 are anchored against further downward movement, as for example by means of cables 49, secured between the header 31 and the hammer leads, not shown.

The ram 38 is then raised to the surface and concrete is poured into the mandrel 25. Ram 38 is reinserted into the mandrel 25, coming to rest on the upper surface of the concrete (see FIG. 7). Hammering is resumed, whereby the concrete is tamped and forced out into the surrounding earth strata. Tamping is terminated before the hammer anvil again engages the header 31 (see FIG. 8). The ram is withdrawn and more concrete poured in. This concrete is tamped to enlarge the ball. The tamping and pouring steps are repeated until a ball of the desired size has been formed. The required size of the ball will be determined by the number of hammer blows required to tamp the incremental portions of concrete into place.

After formation of the ball, the bolt 37 is reinserted and the pressure fluid is vented from the bags 29. The mandrel and ram assembly is then withdrawn from the casing.

After inspection, the casing may be filled with concrete. Reinforcing may be used in the resulting pile if desired. It is contemplated that in practice, several balls will be formed and the shafts poured in a group. This will lend flexibility to the operation and result in economies in the pouring operation.

It is unnecessary to describe in detail the operation of the alternate embodiments of FIGS. 2, 4 and 5. The FIG. 2 form of closure is used where the strata in which the ball is to be formed is cohesive, as contrasted to granular. Use of this closure causes the formation of a depression of the same form as the closure beneath the casing 21. In cohesive soil, the conoidal form of the depression will be maintained until concrete is poured in and tamped and uniform lateral expansion of the concrete into the surrounding soil is enhanced. Use of the conoidal form of closure is preferred, but it cannot be satisfactorily used if the soil is granular and has a tendency to fill the impression when the ram is withdrawn.

While the preferred apparatus and alternate form of it have been described in detail, the practice of the method of this invention is not limited to the use of this precise equipment. No limitation of this invention to the described apparatus is implied except as is expressly stated in the appended claims.

What is claimed is:

1. Apparatus for forming encased, cast-in-place concrete ball piles comprising in combination the casing; an inward directed annular flange at the lower end of said casing; a rigid tubular mandrel fitted into, and connected with and guiding the casing, said mandrel being at least as long as said casing; a seat formed on the mandrel at its lower end arranged to engage and seal against the upper face of said flange; a ram guided in said tubular mandrel; closure means carried by said ram at its lower end and fitted to the inner wall of said mandrel; means selectively effective or ineffective to connect said ram and mandrel together as a unitary structure in positions such that the closure means closes the lower end of the mandrel; and an anvil connected with said ram whereby hammer blows on said anvil may be delivered to said casing, mandrel and ram as an assembly or to said ram alone, depending upon the condition of the selectively effective means.

2. In apparatus for forming encased, cast-in-place concrete ball piles, the combination of a thin-walled casing; a rigid mandrel tube in said casing and having an outer diameter less than the inner diameter of said casing, said tube being at least as long as said casing; means reacting between said tube and casing throughout substantially the entire length of the casing; annular sealing means between the lower ends of said tube and said casing; a ram guided in said tube; releasable means securing said ram and tube together in positions in which their lower ends are adjacent one another; and a closure carried by the ram at its lower end and having a diameter equal to the inner diameter of the tube whereby the lower end of the tube is closed when said ram is locked in position in said tube.

3. The combination defined in claim 2 in which said closure comprises a conoidal member whose base is secured to the lower end of the ram, the conoidal portion extending downward.

4. The combination defined in claim 2 and a hammer anvil connected with the ram whereby the casing, tube and ram are subject to hammer blows as a unit when said releasable means is effective or the ram only is subject to hammer blows when the releasable means is ineffective.

5. In apparatus for forming encased, cast-in-place concrete ball piles, the combination of a thin-walled casing; a rigid mandrel tube in said casing having an outer diameter less than the inner diameter of said casing, said tube being at least as long as said casing; means reacting between said tube and said casing throughout substantially their entire length; annular sealing means between the lower ends of said tube and said casing; a ram guided in said tube; fastening means selectively effective or ineffective to secure said ram and tube together in positions in which their lower ends are adjacent one another; anchoring means selectively effective or ineffective to restrain said mandrel tube against downward longitudinal movement, said fastening means and said anchoring means being alternately effective; and a closure carried by the ram at its lower end and having a diameter equal to the inner diameter of the tube whereby the lower end of the tube is closed when said ram is locked in position in said mandrel tube.

6. Apparatus for forming encased, cast-in-place concrete ball piles, comprising a thin-walled casing; a rigid mandrel tube in and at least as long as said casing; means extending inward from said casing for contact with said tube; means for driving said mandrel tube downward; means for transmitting downward movement from said tube to said casing; a ram extending within said tube and connected to said driving means; closure means on the ram, said closure means and the inward extending means sealing one end of the casing; and means for

disconnecting said driving means from said mandrel tube for enabling said driving means to drive said ram independently of said mandrel tube and said casing.

7. Apparatus for forming encased, cast-in-place concrete ball piles, comprising a thin-walled casing; a rigid mandrel tube in said casing; means extending inward from said thin-walled casing for contact with said rigid mandrel tube; means for driving said mandrel tube downward; means for transmitting downward movement from said tube to said casing; a ram extending within said tube and connected to said driving means; closure means carried by said ram and fitted to the inner wall of said tube, said closure means and said inward extending means

forming a seal at one end of said casing; and means for disconnecting said driving means from said mandrel tube for enabling said driving means to drive said ram independently of said mandrel tube and said casing.

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UNITED STATES PATENT OFFICE

Certificate of Correction

Patent No. 3,005,315 October 24, 1961

Walter H. Cobi

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 14, before "means" insert —locking—; line 15, for "connect" read —lock—; line 16, for "and" read —to said—; same line 16, strike out "together as a unitary structure"; lines 21 and 22, after "effective" insert —locking—; lines 31, 45, and 46, before "means", each occurrence, insert —locking—; line 56, for "secure" read —lock—; column 4, lines 66 to 75, and column 5, lines 1 to 13, and column 6, lines 1 to 4, claims 6 and 7 should appear as shown below instead of as in the patent:

6. Apparatus for forming encased, cast-in-place concrete ball piles, comprising a thin-walled casing; a rigid mandrel tube in and at least as long as said casing; means extending inward from said casing for contact with said tube; means for driving said mandrel tube downward; means for transmitting downward movement from said tube to said casing; a ram extending within said tube; locking means for locking said ram to said mandrel tube; and closure means on the ram, said closure means and the inward extending means sealing one end of the casing; said locking means being, selectively, effective to lock said ram to said mandrel tube to form a single driving unit or ineffective whereby, when said locking means is ineffective, said ram may be driven independently of said mandrel tube and said casing.

7. Apparatus for forming encased, cast-in-place concrete ball piles, comprising a thin-walled casing; a rigid mandrel tube in said casing; means extending inward from said thin-walled casing for contact with said rigid mandrel tube; means for driving said mandrel tube downward; means for transmitting downward movement from said tube to said casing; a ram extending within said tube; an aperture in said ram and an aperture in said mandrel tube, said apertures being aligned when said ram is in position in said tube; a lock selectively engageable in said apertures for locking said ram to said mandrel tube; and closure means carried by said ram and fitted to the inner wall of said tube, said closure means and said inward extending means forming a seal at one end of said casing; said lock being selectively disengageable from said apertures to unlock said ram from said mandrel tube to enable said driving means to drive said ram independently of said mandrel tube and said casing.

Signed and sealed this 3rd day of July 1962.

[SEAL]

Attest:

ERNEST W. SWIDER,
Attesting Officer.

DAVID L. LADD,
Commissioner of Patents.