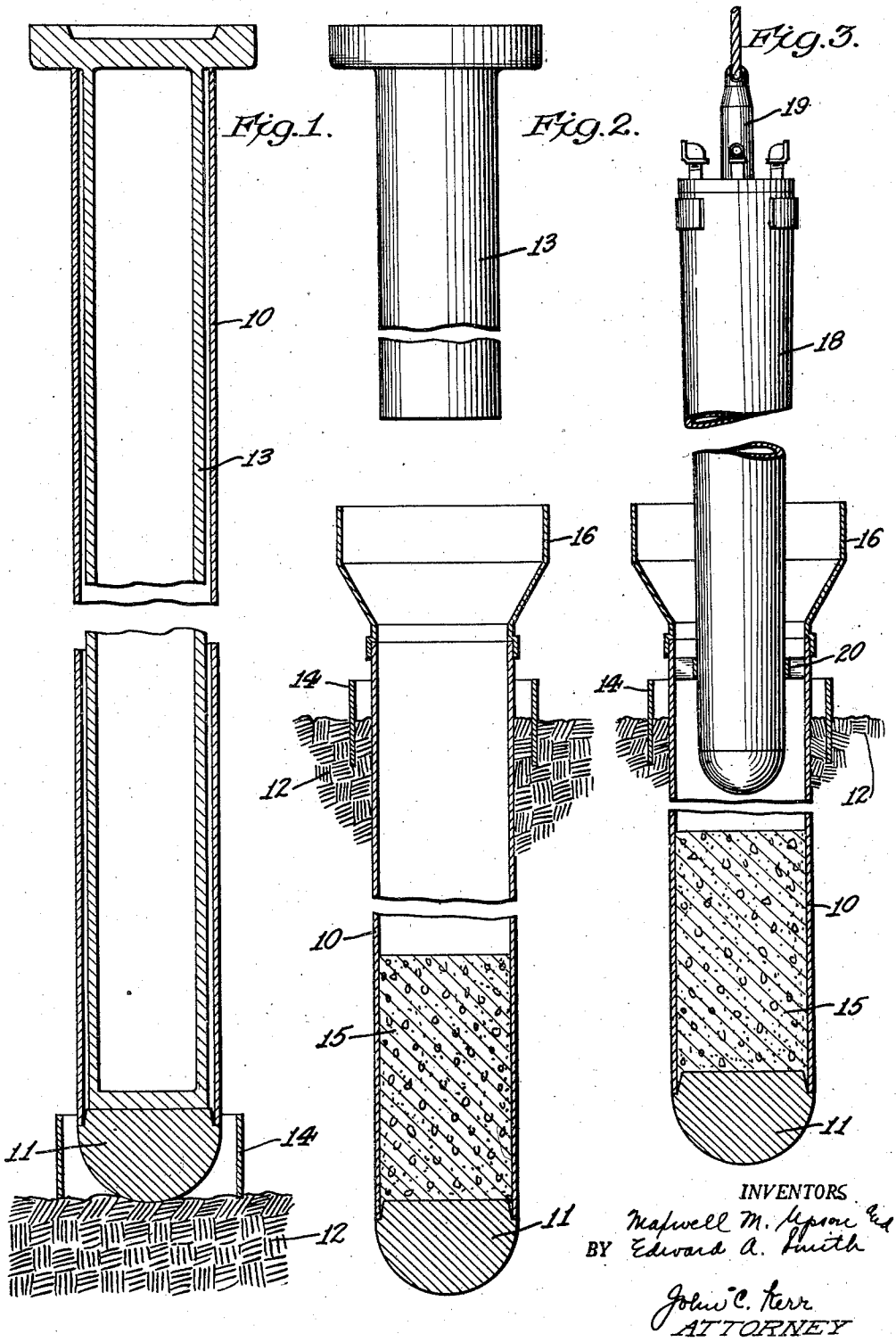
June 3, 1947. M. M. UPSON ET AL 2,421,666

METHOD OF AND APPARATUS FOR MAKING CONCRETE PILES

Filed Oct. 18, 1944 5 Sheets-Sheet 1



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METHOD OF AND APPARATUS FOR MAKING CONCRETE PILES

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Fig. 4.

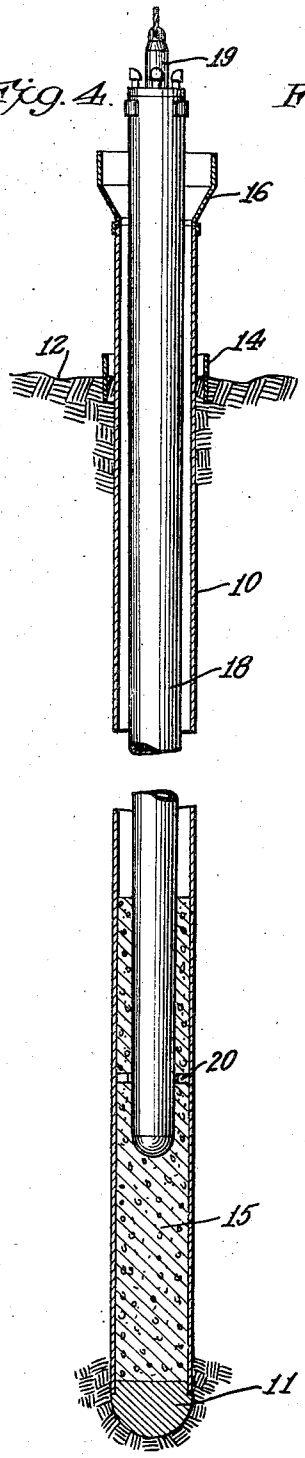


Fig. 5.

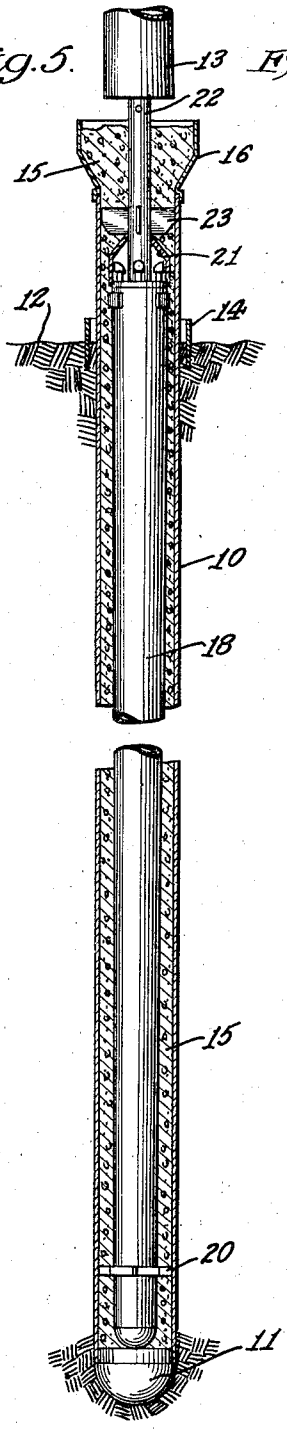
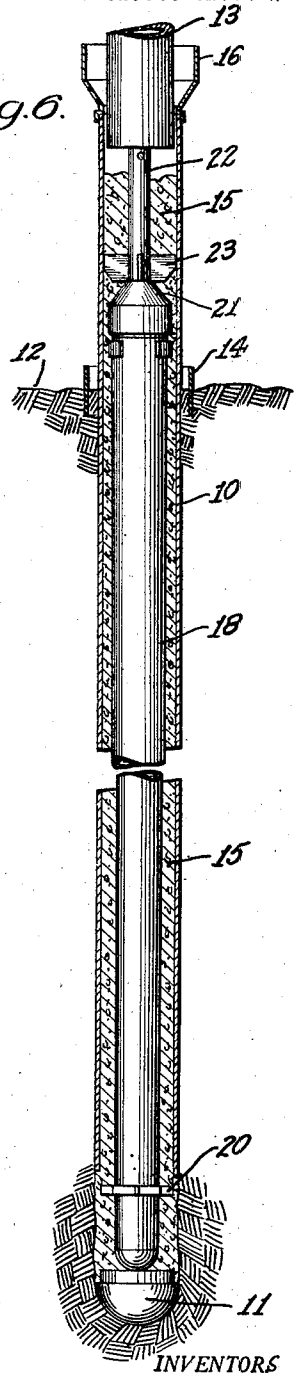


Fig. 6.



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METHOD OF AND APPARATUS FOR MAKING CONCRETE PILES

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Fig. 7.

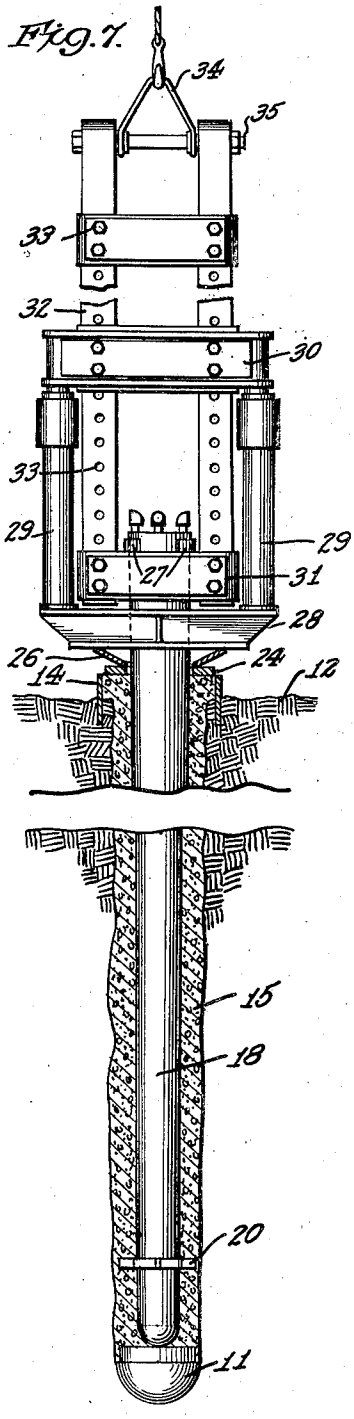


Fig. 8.

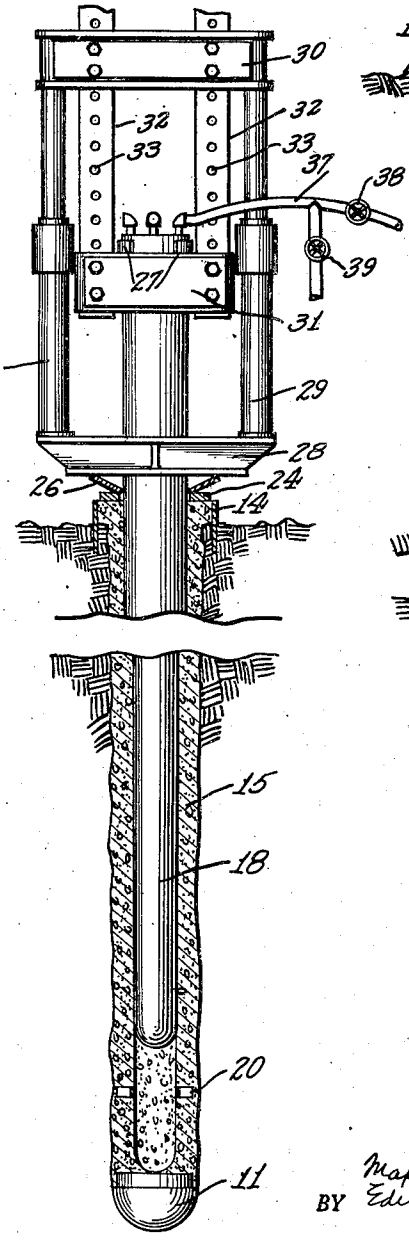
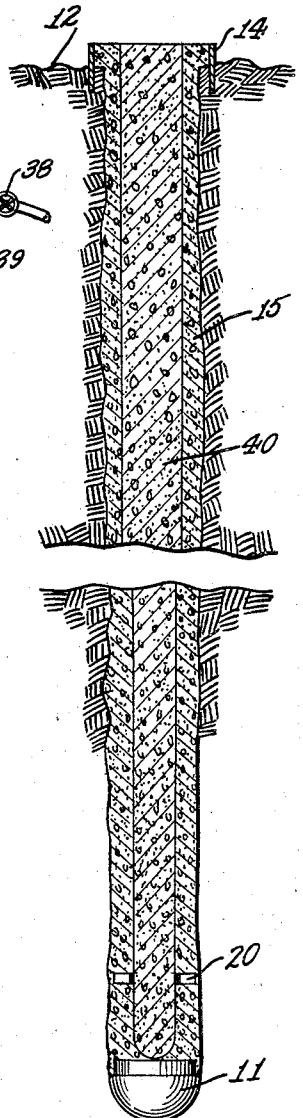


Fig. 9.



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METHOD OF AND APPARATUS FOR MAKING CONCRETE PILES

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Fig. 10.

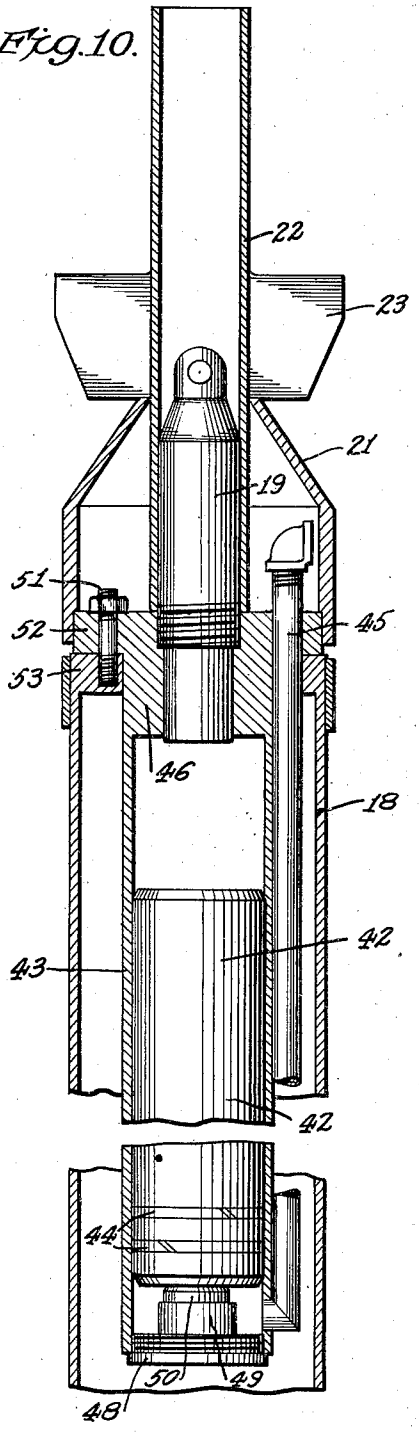

Fig. 11.

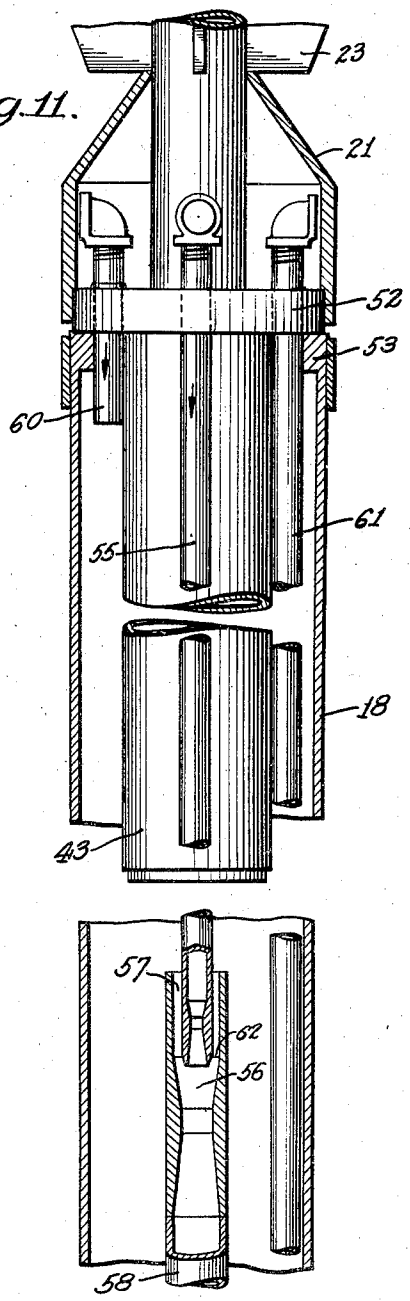

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Fig. 12.

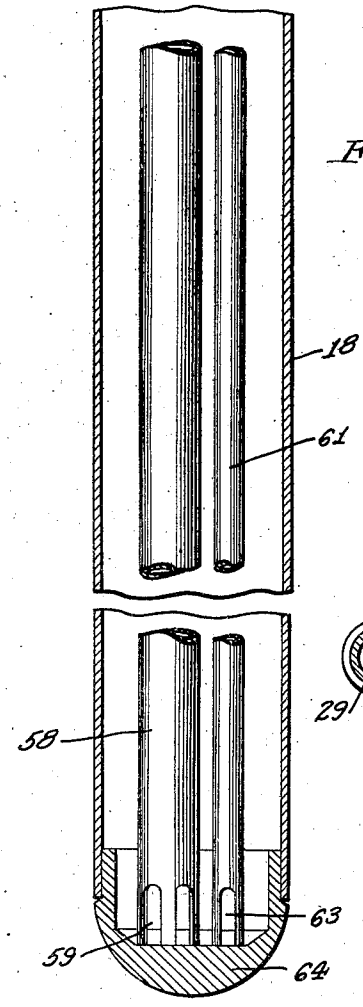


Fig. 14.

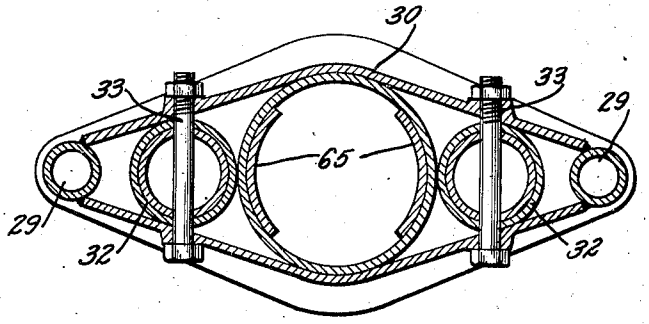
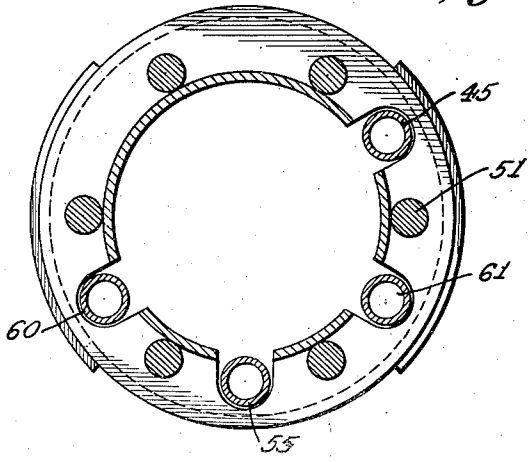


Fig. 13.



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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR MAKING CONCRETE PILES

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Application October 18, 1944, Serial No. 559,168

11 Claims. (Cl. 61—57)

1

This invention relates to the manufacture of cast-in-place concrete piles by first casting a concrete shell in the ground and later filling this shell with concrete.

An object of the invention is to provide an improved method and means for casting the concrete shell of the pile in the ground.

Another object is to accomplish the foregoing purpose through the advantageous use of a tapered, hollow, watertight, non-collapsible, metal inside form.

Another object is to expedite the curing of the concrete shell so as to require a minimum number of forms on a given job and to minimize deformation of the shell due to ground pressure.

Still another object is to facilitate removal of the form from the ground by jacking or hammering or by a combination of the two.

Various other objects and advantages will be apparent from the specification and claims, taken in connection with the accompanying drawings which illustrate what is now considered to be a preferred embodiment of the invention.

In the drawings,

Fig. 1 shows a casing 10 and its shoe 11 ready to be driven to the desired depth in the ground 12 by the drive core 13, the pile hammer being omitted from the drawing in order to simplify the showing. A sleeve 14, which may be split, is preferably used at the surface of the ground 12.

Fig. 2 shows the next step in the process. Driving has been completed. Drive core 13 has been removed and a predetermined quantity of plastic concrete 15 has been placed in the bottom of the casing 10. This concrete may well contain an accelerant such as calcium chloride. A funnel 16 has been placed on top of the casing 10 to assist in the placing of the concrete 15. Later on, this funnel 16 serves as a reservoir to retain concrete which would otherwise overflow, as will be hereinafter described. Sleeve 14 has been driven into the ground a short distance by means of hand sledges or in any other convenient manner.

Fig. 3 shows the tapered, watertight, hollow form 18 being entered into casing 10. The form 18 is suspended by means of the removable hoisting plug 19. The lower end of form 18 carries a spider centering ring 20. If desired, the concrete 15 may be poured in after form 18 has been lowered into the casing, but in such case air pockets may form in the concrete.

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In Fig. 4 the form 18 has entered into casing 10 and has been allowed to settle of its own weight into the plastic concrete 15. Unless of unusually heavy construction, form 18 will float in the concrete 15 without going all the way to the bottom.

Fig. 5 shows form 18 pushed to the bottom of the plastic concrete 15 by the cumulative weight of core 13 and the pile hammer acting through a pusher pipe 22. This pusher pipe 22 is held rigidly in line with form 18 by a close fit around hoisting plug 19 and is equipped with an integral spider guide 23 to hold the top of form 18 central with casing 10. Any excess concrete 15 which rises above form 18 will be accommodated around pusher pipe 22 by the upper end of casing 10 and funnel 16. A shield 21 around the pusher pipe and below the spider guide 23 covers the top of the form 18 and prevents the concrete from covering or entering pipes provided within the form for purposes hereinafter made clear.

Fig. 6 shows the casing 10 being withdrawn after form 18 has reached the proper depth. The plastic concrete 15 fills the space vacated by casing 10.

After the casing 10 has been completely withdrawn, the plastic concrete 15 is leveled at the top of sleeve 14 and a stiff ring 24 is set on top, as shown in Fig. 7, so as to serve as a reaction for subsequent jacking operations. Form 18 may then be heated as described below, or by other suitable means, and the surrounding concrete 15 allowed to harden. Heating the form serves to hasten the setting of the concrete, thus reducing to a minimum the number of forms which must be used on any given construction job; it also makes possible the practice of the invention in cold weather which would otherwise freeze the concrete; it furthermore serves to expand the form 18 slightly, both horizontally and vertically, with the result that when the form is later cooled, there is a tendency for it to free itself from the concrete.

Heating of the form 18 may be continued actively during the setting of the concrete, after which the form may be cooled artificially in any suitable manner to assist in its removal. However, we have found in practice that the most

satisfactory method of heating and subsequently cooling the form 18 is to leave a fluid such as water in the hollow interior of the form at all times, and to heat this water to approximately 212° F. by the introduction of live steam immediately after withdrawing the casing 10 from the ground, then to allow this water to cool naturally while the concrete is hardening.

After the concrete 15 has set into a hard shell, the form 18 is removed by jacking and hammering. Sometimes jacking alone is sufficient; at other times hammering alone may be sufficient; usually a jacking load approaching the permissible bearing capacity of the concrete is used in combination with a hammer blow. In rare instances it may be necessary to cool the form artificially, as by refrigerating the interior of the form, to break it free.

Figs. 7 and 8 show the removal of the form 18. A heavy spring ring 26 is placed on top of ring 24. Jacking equipment is then lowered over the head of form 18 and engaged, by a suitable bayonet lock arrangement, with lugs 27 on the form. The jacking equipment comprises a base 28, two jacks 29, a top cross yoke 30, two jacking collars 31, two fleeting pipes 32 with pins 33, and lifting bale 34 with bolt 35.

Jacking pressure is applied up to the safe bearing capacity of the concrete shell 15, thus compressing the spring 26. If the bond is broken, jacking is continued until the form 18 comes free and can be lifted out. If jacking is insufficient, as is usually the case, a hammer built into the form is operated by compressed air through hose 37, shown in Fig. 8. Inlet valve 38 is opened to admit air to strike a blow, and valve 39 is used for exhaust. Spring 26 increases the movement of form 18 at each hammer blow.

Fig. 9 shows the completed pile. The form 18, ring 24, spring 26, and all jacking equipment have been removed, leaving the concrete shell 15, centering ring 20 and shoe 11 permanently in the ground. After the center of the concrete shell has been inspected, it is filled with concrete 40. The sleeve 14 may be left in place, or it may be removed for reuse.

Fig. 10 illustrates the construction and operation of the internal hammer referred to above, which is built into the form 18. Ram 42 operates as a piston in cylinder 43 and is equipped with piston rings 44. Compressed air admitted through pipe 45 drives the ram upward to deliver a blow against anvil block 46. Before such a blow can be struck, hoisting plug 19 must be removed so as to permit the escape of air from above the ram. The pusher pipe 22 is also removed before hammering starts.

Removable cylinder head 48 carries cup 49 containing cushion block or spring 50 to cushion the descent of ram 42. The blow delivered to anvil block 46 is transmitted by studs 51 to form 18. Studs 51 and flanges 52 and 53, on top of anvil 46 and form 18, permit slight elastic deformation under the impact of the blow and prevent breakage of form 18. While an internal hammer is shown herein for purposes of illustration and is preferred, an external hammer connected to the form by suitable linkage may be used instead.

Figs. 11, 12 and 13 show the piping arrangements for heating and cooling the form 18. Water may be introduced through any of the pipes shown, for example through pipe 61. Steam to heat this water is introduced under pressure through pipe 55 to steam syphon 56. Water is sucked in at the top of the syphon through passage 57 and is driven down through pipe 58 and emitted through slots 59, as shown in Fig. 12. This produces a steady and even heating of the form throughout its length. The condensed steam may be allowed to overflow through pipe 60 or pipe 61. Overflow from pipe 60 may be used to measure the temperature of the water near the top of the form. Overflow from pipe 61 may be similarly used to measure the temperature at the bottom of the form. We have found it most convenient in practice to continue admission of live steam through pipe 55 until the water in form 18 is heated to the boiling point or near it, at which time steam instead of water will issue from pipe 60. The steam supply is then shut off, and, if necessary, additional water is added through pipe 60 to fill the form to the top.

If later on it is desired to cool the form artificially, the heated water may be driven out by plugging the top of pipe 55 and supplying compressed air to pipe 60. This will force the water into slot 63 and out through pipe 61. If sudden cooling is required, cold water may then be introduced through pipe 60. Pipes 58 and 61 are supported by point 64, as shown in Fig. 12. Pipes 55 and 61 are a close fit in flange 52. Pipe 55 is rigidly attached to pipe 58 by radial web members 62 (Fig. 11). This construction is adapted to prevent breakage of these pipes by the blow of the hammer. Pipe 60, being short and light, can be welded into flange 52.

Fig. 14 is a transverse section through top cross yoke 30 in Figs. 7 and 8, showing the bayonet lock lugs 65 which engage with lugs 27 on form 18. Jacking collars 31 are equipped with similar lugs 65, thus making it possible to catch lugs 27 on form 18 at any convenient height.

We have found in practice that the form 18 can be removed successfully without the use of any surface lubricant such as oil. Any such lubricant would be objectionable because it might weaken the bond between the shell concrete 15 and the concrete 40 in the center of the pile. We have further found that the form herein disclosed is self-cleaning because of friction with the concrete during withdrawal, and that no additional cleaning is necessary before reuse.

Although certain specific features have been shown and described herein for purposes of illustration, it will be evident to those skilled in the art that the invention is capable of various modifications and adaptations within the scope of the appended claims.

What we claim is:

1. Method of forming a concrete mold in the ground which comprises sinking a tubular casing into the ground, lowering into said casing a hollow watertight form of appreciably smaller diameter than said casing, filling the space between said casing and said form with concrete, removing said casing, admitting water into the hollow interior of said form, introducing live steam into said water to heat same and thereby assist in solidifying said concrete, and then removing said form.

2. Method of forming a concrete mold in the ground which comprises sinking a tubular casing into the ground, lowering into said casing a hollow watertight form of appreciably smaller diameter than said casing, filling the space between said casing and said form with concrete, removing said casing, admitting water into the hollow interior of said form, introducing live steam into said water to heat same and thereby assist in solidifying said concrete, allowing said water to

cool gradually to assist in freeing said form from the concrete, and then removing said form.

3. Method of forming a concrete mold in the ground which comprises sinking into the ground an empty tubular casing having a closed lower end, pouring a predetermined quantity of concrete into said casing, lowering into said concrete a hollow watertight form of appreciably smaller diameter than said casing thereby causing said concrete to rise into the annular space between said casing and said form, admitting water into the hollow interior of said form, heating said water to assist in solidifying said concrete, and then removing said form.

4. Method of forming a concrete mold in the ground which comprises sinking a tubular casing into the ground, lowering into said casing a hollow closed form of appreciably smaller diameter than said casing, filling the space between said casing and said form with concrete, removing said casing, heating the interior of said form to accelerate solidification of said concrete, cooling said form to assist in freeing it from the concrete, and then hammering the interior of said form and removing it from the ground.

5. Method of forming a concrete mold in the ground which comprises sinking a tubular casing into the ground, lowering into said casing a hollow watertight form of appreciably smaller diameter than said casing, filling the space between said casing and said form with concrete, removing said casing, admitting water into the hollow interior of said form, introducing live steam into said water to heat same and thereby accelerate solidification of said concrete, allowing said water to cool gradually to assist in freeing said form from the concrete, and then jacking said form and hammering the interior thereof to remove same from the ground.

6. In apparatus for forming a concrete mold in the ground and including a tubular casing adapted to line a hole in the ground, the combination comprising a hollow form of appreciably smaller diameter than said casing adapted to fit inside said casing with an annular space between the two for the admission of concrete, means for freeing and extracting said hollow form from concrete between said hollow form and tubular casing, said means including a hammer in the interior of said form including a longitudinal cylinder, an anvil block at the top of said cylinder secured to said form, a ram freely movable in said cylinder, and means for admitting compressed air to said cylinder to actuate said ram.

7. In apparatus for forming a concrete mold in the ground and including a tubular casing adapted to line a hole in the ground, the combination comprising a hollow form of appreciably smaller diameter than said casing adapted to fit inside the casing with an annular space between the two for the admission of concrete, means for heating said form, means for freeing and extracting said hollow form from concrete between said hollow form and tubular casing, said means including a hammer in the interior of said form including a longitudinal cylinder, an anvil block at the top of said cylinder secured to said form, a ram freely movable in said cylinder, and means for admitting compressed air to said cylinder to actuate said ram.

8. In apparatus for forming a concrete mold in the ground and including a tubular casing adapted to line a hole in the ground, the combination comprising a hollow watertight form of appreciably smaller diameter than said casing

adapted to fit inside said casing with an annular space between the two for the admission of concrete, means for admitting water to the interior of said form, means for admitting steam to the interior of said form to heat said water, means for freeing and extracting said hollow form from concrete between said hollow form and tubular casing, said means including a hammer in the interior of said form including a longitudinal cylinder, an anvil block at the top of said cylinder secured to said form, a ram freely movable in said cylinder, and means for admitting compressed air to said cylinder to actuate said ram.

9. In apparatus for forming a concrete mold in the ground a tubular casing adapted to line a hole in the ground, a hollow, tapered and non-collapsible watertight form of appreciably smaller diameter than said casing adapted to fit inside said casing with an annular space between the two for the admission of concrete, means for withdrawing said casing from the ground, means for admitting water to the interior of said form, means for admitting steam to the interior of said form to heat said water, a hammer in the interior of said form including a longitudinal cylinder, an anvil block extending into said cylinder from the largest end of said form, a cushioning block in said cylinder and located remote from the largest end of said form, a ram freely movable in said cylinder, and means for admitting compressed air to said cylinder to actuate said ram.

10. In apparatus for forming a concrete mold in the ground and including a tubular casing adapted to line a hole in the ground, the combination comprising a hollow tapered form adapted to fit inside the casing with an annular space between itself and the casing for the admission of concrete, means for admitting water to the interior of said tapered form, means for admitting steam to the interior of said tapered form to heat water contained therein, jacking means adapted to bear upon concrete surrounding said tapered form and engage the upper end of said tapered form to assist in freeing said tapered form from the surrounding concrete, a hammer in the interior of said tapered form including a longitudinal cylinder, an anvil block extending into said cylinder and located adjacent the largest end of said tapered form, a ram freely movable in said cylinder, and means for admitting compressed air to said cylinder to actuate said ram against said anvil block, whereby, through the cooperation of said jacking means and the actuation of said hammer against said anvil block, said tubular form is freed from the surrounding concrete.

11. In apparatus for forming a concrete mold in the ground, the combination comprising a hollow watertight tapered form having its small end closed and formed for advancing through plastic concrete, means attached to the larger end of said tapered form for receiving the impact of blows for advancing said tapered form through concrete, a conduit extending from the larger end of said tapered form and opening adjacent the lower end of said tapered form for admitting water to the interior of said form, a second conduit extending from the larger end of said form and ending intermediate the ends of said form for introducing steam to water contained in said form, a third conduit having one end in spaced and telescoping relation to the discharge end of said second conduit and its other end discharging into the water contained in said form whereby the water in said form is circulated when steam is

introduced into said second conduit, an overflow conduit at the upper end of said form, and a removable shield covering the upper ends of said conduits and surrounding said first-named means for preventing the entry of foreign material to said conduits while said form is being driven.

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EDWARD A. SMITH.

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