

April 29, 1924.

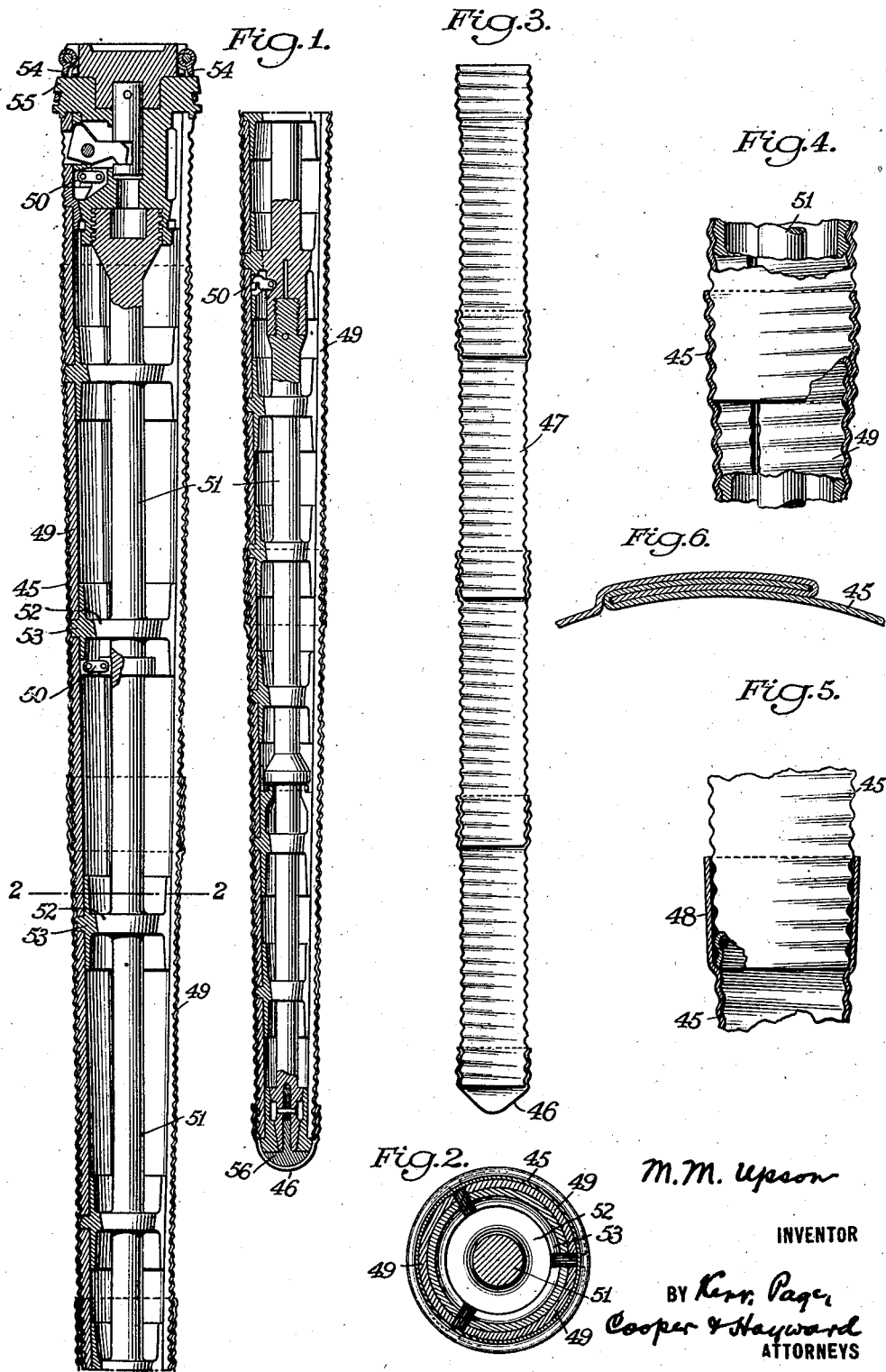
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M. M. UPSON

APPARATUS FOR MAKING CONCRETE PILES

Filed June 18, 1921

10 Sheets-Sheet 1



M. M. Upson

INVENTOR

BY *Kerr, Page,*
Cooper & Hayward
ATTORNEYS

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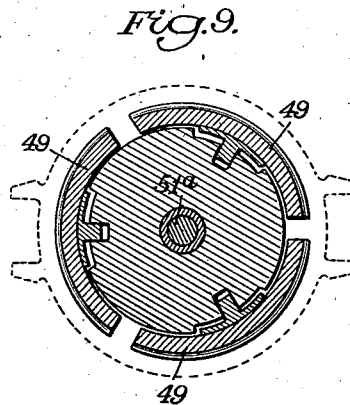
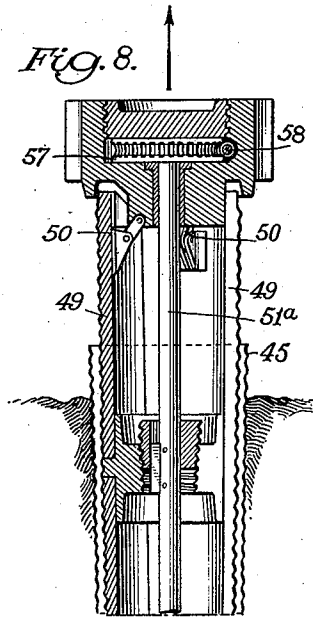
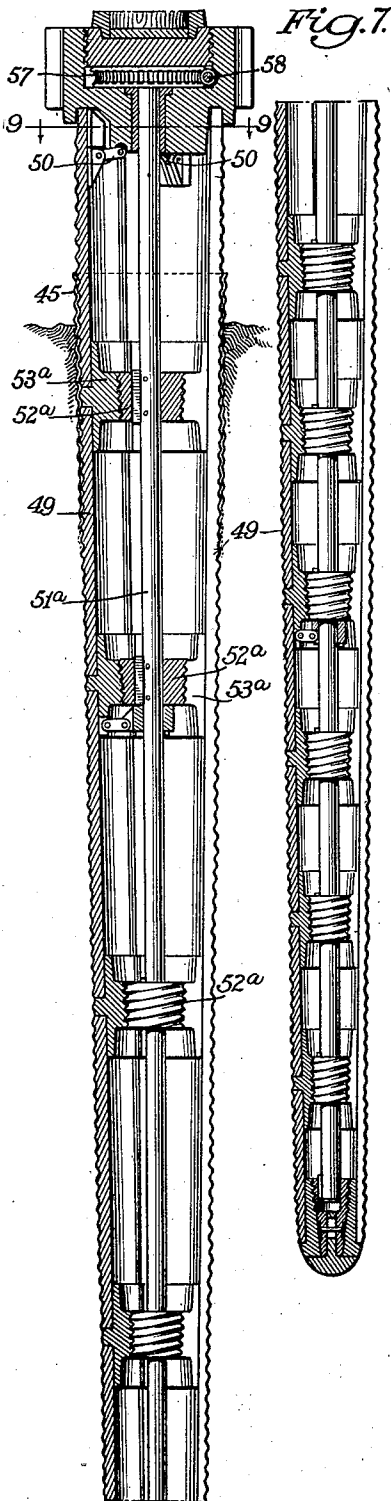
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Fig. 10.

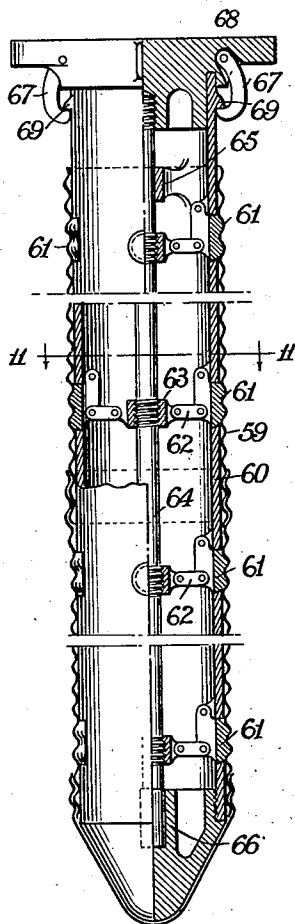


Fig. 12.

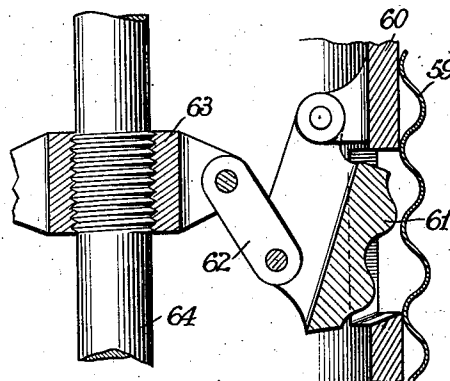


Fig. 13.

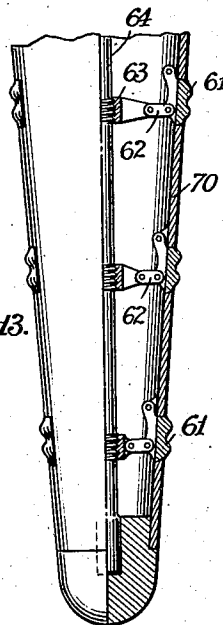
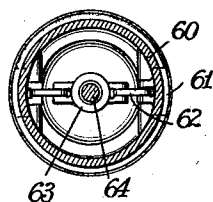


Fig. 11.



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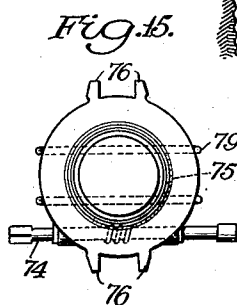
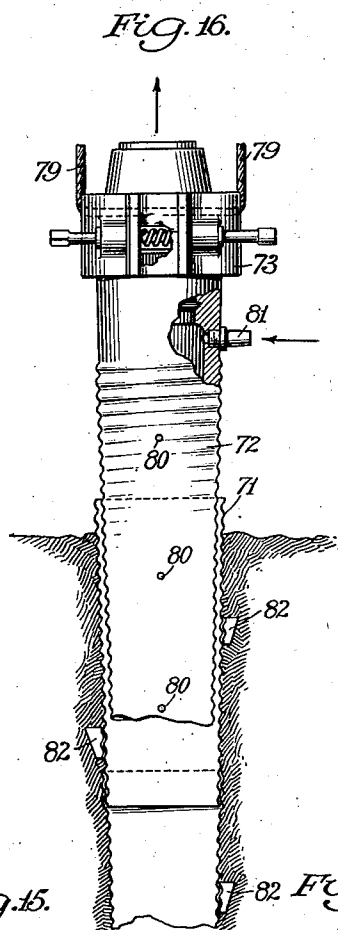
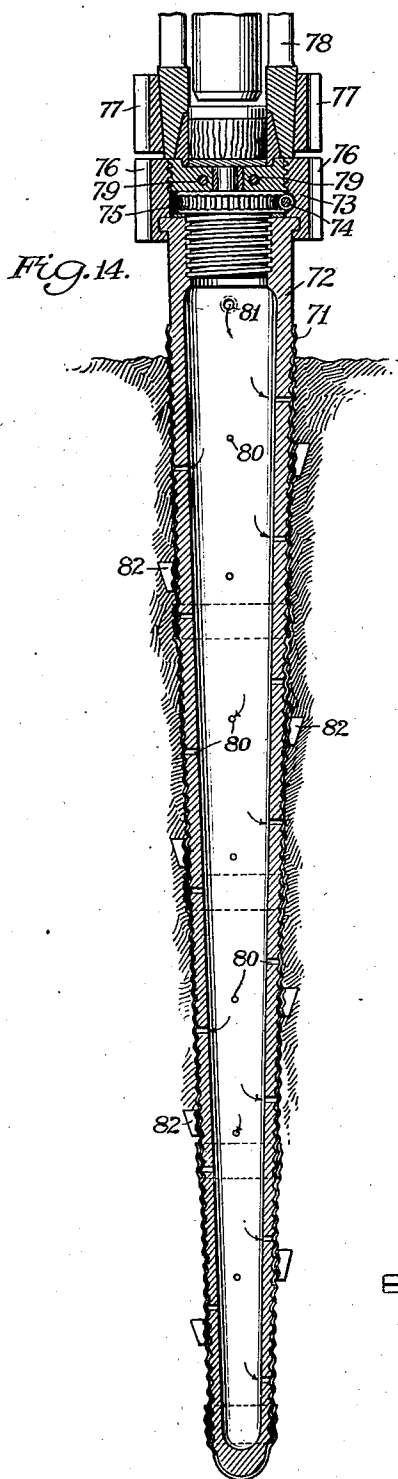
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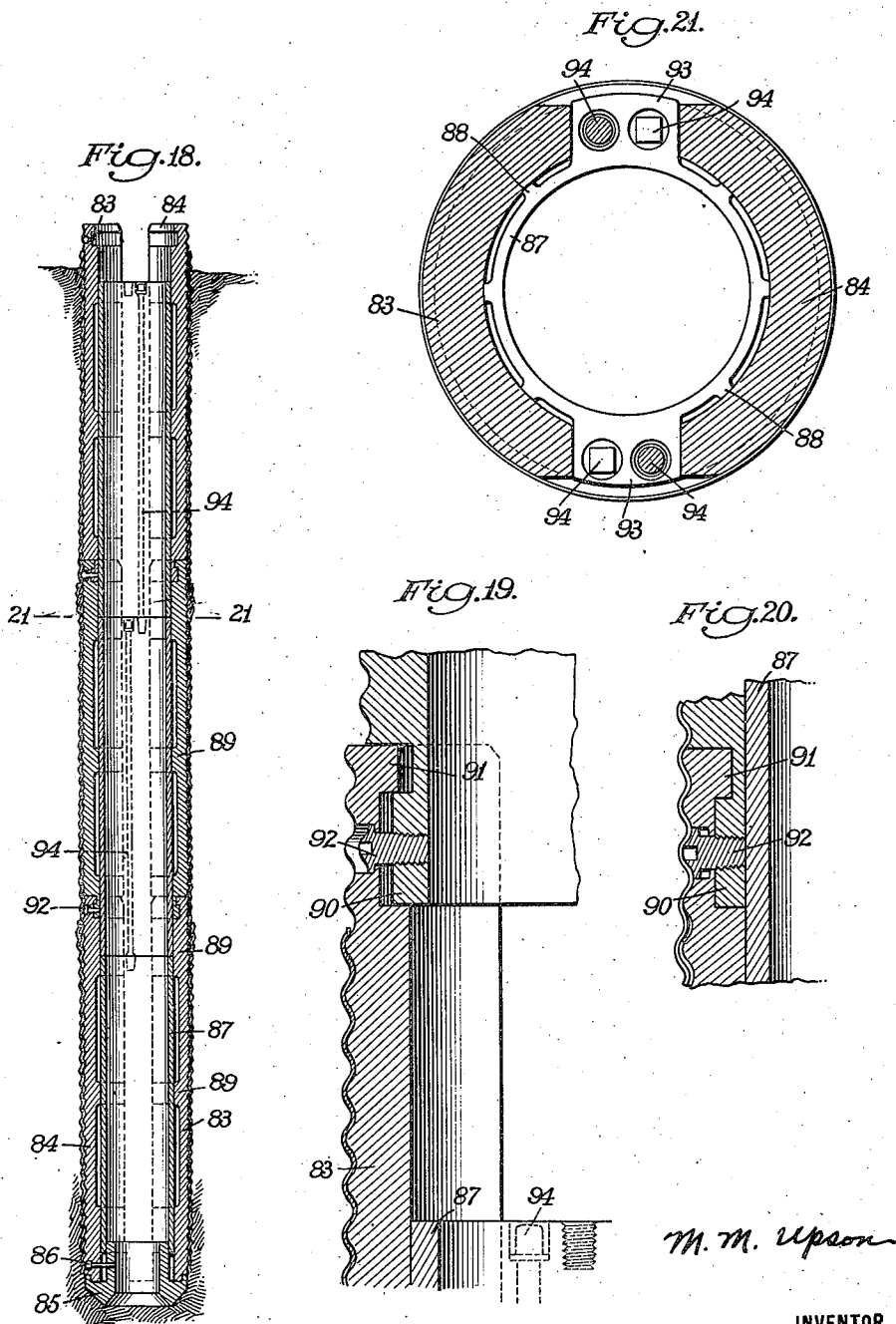
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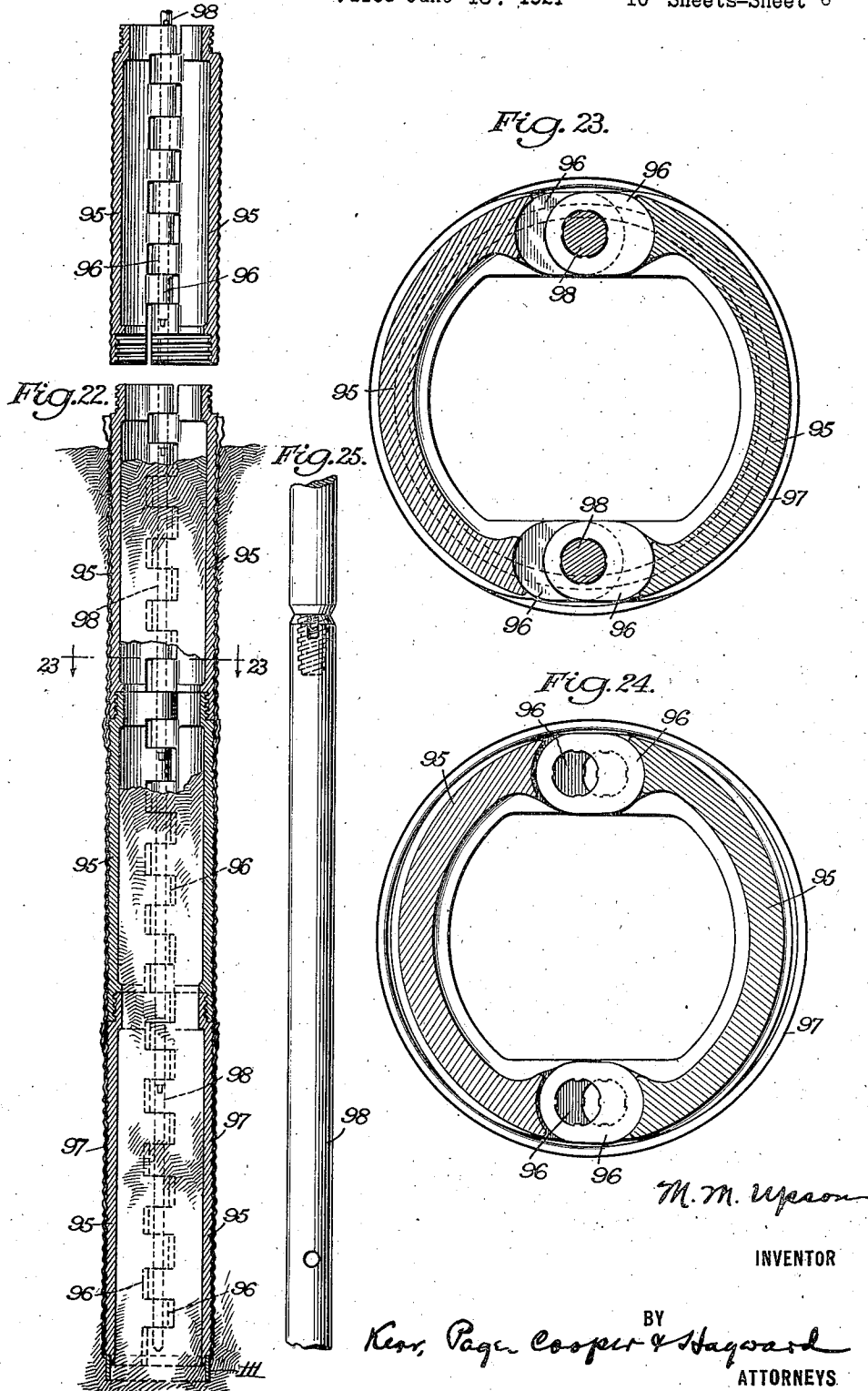
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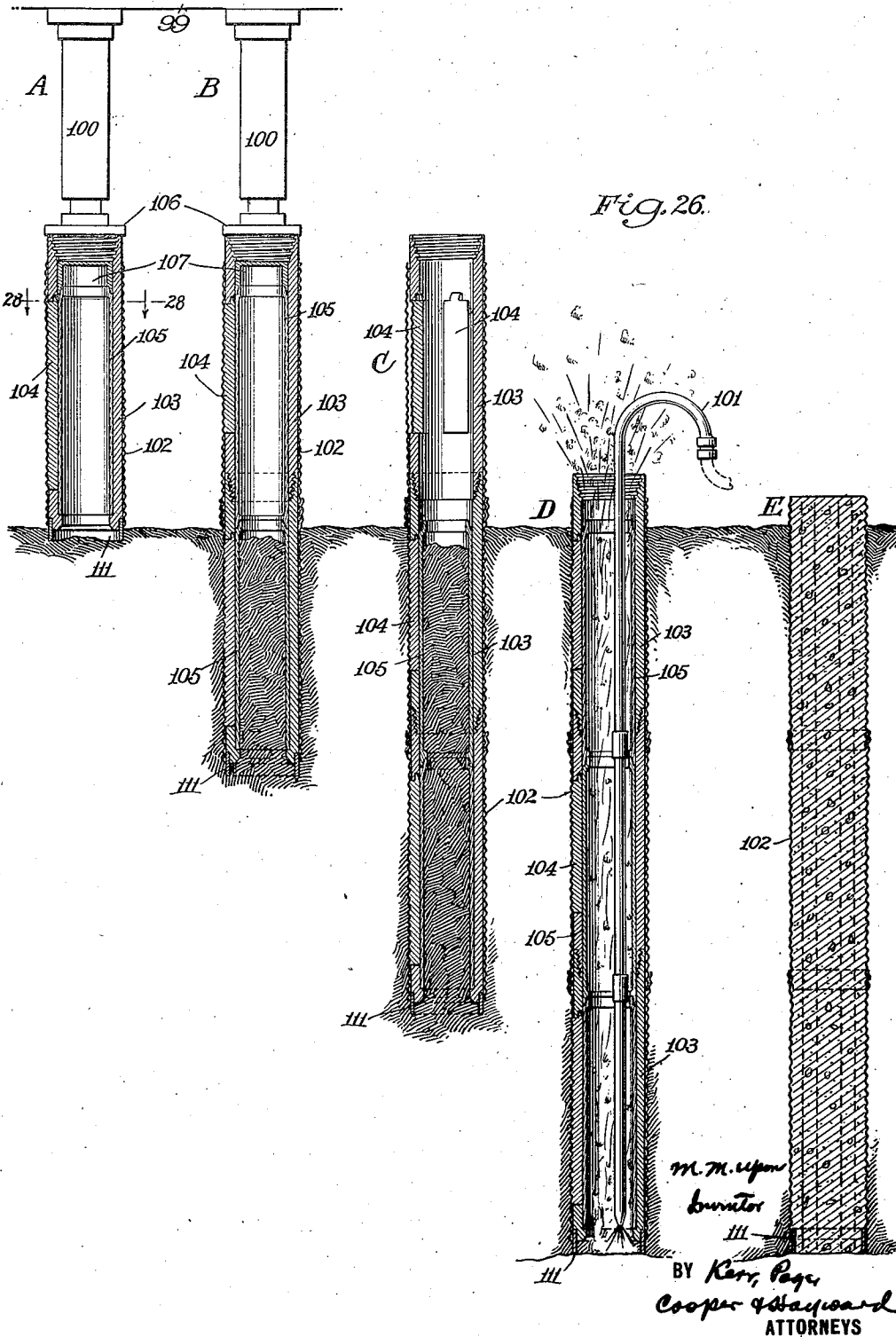
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Fig. 28.

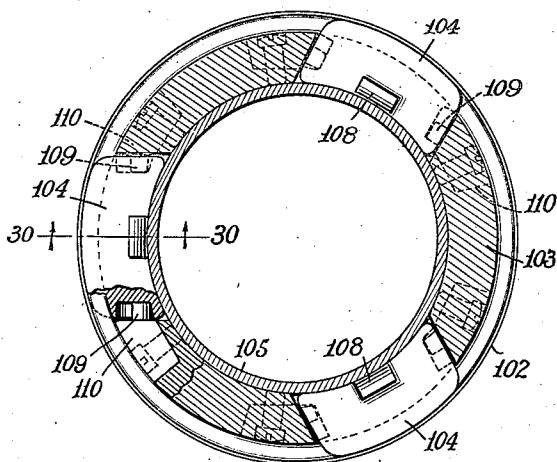


Fig. 31.

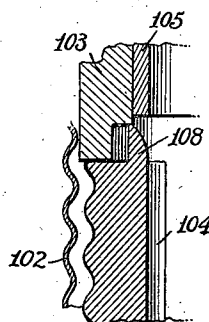


Fig. 29.

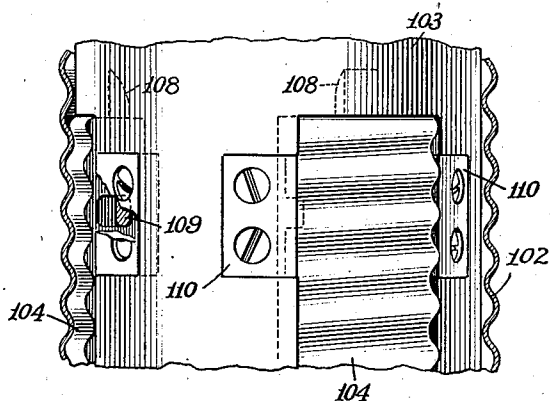
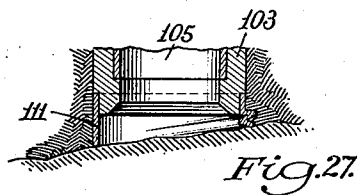
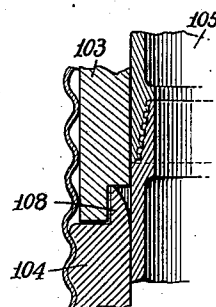


Fig. 30.



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Fig. 32.

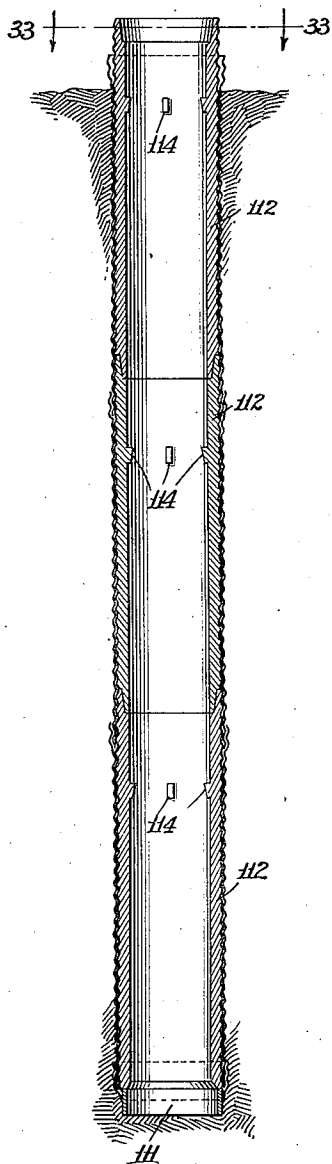


Fig. 33.

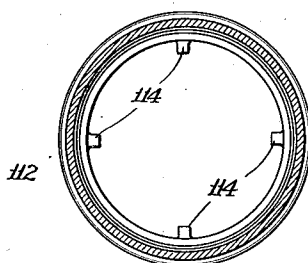
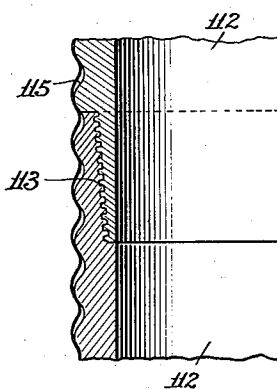


Fig. 34.



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Fig. 36.

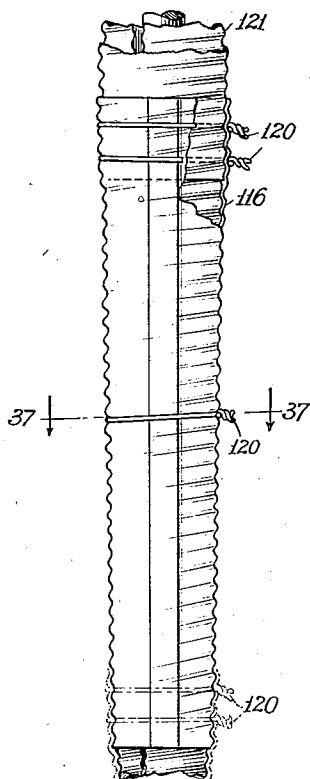


Fig. 37.

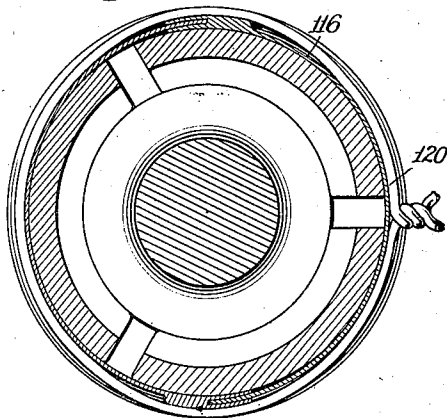


Fig. 35.

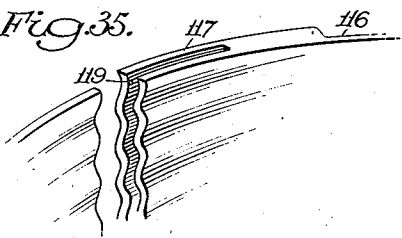


Fig. 38.

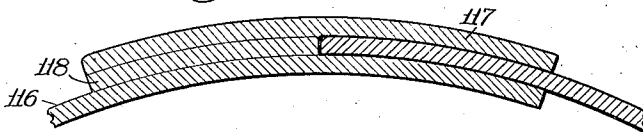


Fig. 39.

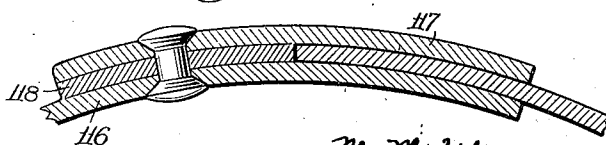
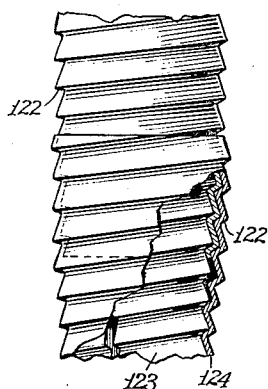


Fig. 40.



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UNITED STATES PATENT OFFICE

MAXWELL MAYHEW UPSON, OF ENGLEWOOD, NEW JERSEY.

APPARATUS FOR MAKING CONCRETE PILES.

Application filed June 18, 1921. Serial No. 478,644.

To all whom it may concern:

Be it known that I, MAXWELL MAYHEW UPSON, a citizen of the United States of America, residing at Englewood, in the county of Bergen and State of New Jersey, have invented certain new and useful Improvements in Apparatus for Making Concrete Piles, of which the following is a full, clear, and exact description.

This invention relates to making concrete piles of the type which is wholly or partly molded in situ, and its chief object is to provide simple and effective means by which a circumferentially corrugated shell or mold of sheet metal may be sunk into the ground to the desired depth without the necessity of protecting the outside of the shell during the sinking operation. For this purpose the corrugated shell is fitted snugly on a correspondingly corrugated core, which takes the driving impact or pressure and by its engagement with the corrugations on the inside of the shell draws the shell down into the ground without permitting the shell as a whole to stretch under the pull and thereby flatten out the corrugations. It is thus possible to utilize the well known resistance of circumferential corrugations to high pressures exerted in a radially inward direction, and at the same time use thin metal without the necessity of enclosing the shell in an outer pipe (during sinking) to prevent its being subjected to longitudinal stretching stresses. I am therefore able to eliminate in practically all cases the costly wire reinforcement heretofore used to strengthen pile shells against the pressure of the earth, and at the same time I can make the shell itself of thinner stock. The net result is an important saving of material, in some cases as much as fifty per cent, with the production of a pile which is in no way inferior and which is in some respects superior to piles made by prior methods.

In practise the shell which I employ may be composed of sections arranged end to end and suitably connected or it may be in a single length, according to the length of the pile. The corrugations are preferably helical, in the form of one or more screw-threads, thereby permitting successive sections to be firmly joined by screwing one into the other, the end of one section being slightly belled or expanded to receive the other section, or

the end of the latter being slightly reduced to enter the end of the other. This method of joining the sections is particularly advantageous, as it locks the sections and makes the shell in effect a unitary tension member, enabling it to resist the powerful longitudinal stresses exerted by upheaval of the ground, which might otherwise pull the sections apart and rupture the concrete before the latter has set. Or both methods may be resorted to; or the belled end of one or the reduced end of the other, or both, may be uncorrugated to provide a simple form of joint which is more or less of the bell-and-spigot type. For some purposes the shell is of uniform diameter or roughly cylindrical throughout, or part or all of it may taper downwardly, and the bottom may be closed by a driving point or boot or may be provided with a driving ring. The core or mandrel with which the shell is combined for driving purposes, and which is provided with outer corrugations to engage the inner corrugations of the shell, may be of various types. For example, it may have, or may be composed of, radially collapsible leaves, segments, or other parts, which, when the core is to be withdrawn after driving, can be moved inwardly toward the axis of the core so as to carry the core-corrugations out of the shell corrugations, thus permitting the core to be lifted out with ease. Or it may be non-collapsible, in which case it can be unscrewed. The latter type is more suitable for a tapered shell, since a few turns suffice to clear the corrugations and leave the core free for withdrawal by hoisting. The core may also be made in longitudinal sections. In some cases of underpinning work, where it is desired to underpin an existing building or other structure, the shell must be sunk in successive sections, as by means of a jack, in which case a core composed of separable sections must be employed, which sections may be joined to each other in any convenient manner and may be screwed into and out of the shell sections or may be provided with radially movable parts for engagement and disengagement with the corrugations of the shell.

Referring now to the accompanying drawings, in which are shown various forms of the embodiments outlined above,

Fig. 1 illustrates in vertical section a ta-

pered shell having screw-thread corrugations, the shell being composed of sections screwed together upon a collapsible core. The left hand portion of the figure shows the upper part of the combination (rather more than half) and the right hand portion shows the remaining lower part.

Fig. 2 is a cross section on line 2—2 of Fig. 1.

Fig. 3 is a vertical sectional view of a cylindrical or untapered shell composed of sections which are screwed together, with a driving boot screwed on the bottom of the lowermost section.

Fig. 4 is an enlarged detail view, mostly in vertical section, illustrating one of the screw joints of the shell shown in Fig. 1.

Fig. 5 is a view similar to Fig. 4 but showing a slip-joint of the bell-and-spigot type.

Fig. 6 is a detail cross section showing the preferred type of joint employed to secure the edges of the sheet metal blank after it is bent to form the shell or shell-section.

Fig. 7 is detail sectional view of the upper part of Fig. 1, showing the core partially withdrawn after being collapsed to free its corrugations from those of the shell.

Fig. 8 is a detail section similar to Fig. 7 but showing the core collapsed and partly withdrawn from the shell.

Fig. 9 is a detail sectional plan on line 9—9 of Fig. 7.

Fig. 10 is vertical section showing an untapered core of the collapsible type having corrugated sections or parts which are movable inwardly and outwardly by a vertically shiftable rod or shaft at the axis.

Fig. 11 is a sectional plan view on line 11—11 of Fig. 10.

Fig. 12 is an enlarged detail section showing in its inner or collapsed position one of the parts of the core illustrated in Fig. 10, and showing also the relation of such core-part to the corrugated shell.

Fig. 13 is a detail view, partly in vertical section, of the lower end of a tapered core of the type illustrated in Figs. 10, 11 and 12.

Fig. 14 is a vertical section showing a tapered shell and core sunk in the ground. The core is non-collapsible and is disengaged from the shell-corrugations by unscrewing preparatory to removal by hoisting.

Fig. 15 is a plan view of the driving head of the core shown in Fig. 14, containing the mechanism for rotating the core to unscrew the same.

Fig. 16 is a detail view of the upper portion of Fig. 14, showing the core lifted part way out of the shell after being disengaged by unscrewing.

Fig. 17 is detail cross section showing one of the fins with which the shell may be provided to prevent rotation as the core is unscrewed.

Fig. 18 is a vertical sectional view illustrating an untapered shell and collapsible core, open at the bottom. The core is also made in relatively short lengths or sections which can be joined end to end.

Fig. 19 is a detail section of parts shown in Fig. 18, illustrating in collapsed position a core-segment of one of the core sections.

Fig. 20 is a view similar to Fig. 19 but showing the core-segment expanded against the shell.

Fig. 21 is a detail sectional plan view on line 21—21 of Fig. 18.

Fig. 22 is a vertical section showing an untapered collapsible core composed of longitudinally separable sections screwed together, inside of a sectional shell.

Figs. 23 and 24 are detail cross sections, both on line 23—23 of Fig. 1, showing a core-section in expanded and in collapsible position, respectively.

Fig. 25 is a detail side view of a portion of one of the jointed rods used to lock the core-parts of Fig. 22 in expanded or outer position.

Fig. 26 is a vertical sectional view illustrating five stages (denoted by A, B, C, D and E) in the operation of placing a pile by "jacking down" into the ground a shell and a core open at the lower end. This figure also illustrates the removal of earth from inside the core by means of a blast of air or other fluid.

Fig. 27 (at the bottom of the sheet containing Figs. 28 to 31 inclusive) is a detail sectional view showing the crushing down of the ring at the bottom of the driving point of the core shown in Fig. 26, when bedrock, or a boulder, or the like, is encountered.

Fig. 28 is a sectional plan view of a core having three radially movable corrugated members, which are shifted outwardly to engage the shell by means of an inner pipe. Both the core and the pipe may be composed of longitudinally separable sections.

Fig. 29 is a detail side view of a portion of the core shown in Fig. 28, with the shell shown in vertical section and engaged by the corrugated members of the core.

Fig. 30 is a detail section on line 30—30 of Fig. 28.

Fig. 31 is a sectional view like Fig. 30 but showing the corrugated member in its inner position, disengaged from the shell.

Fig. 32 is a vertical section illustrating a non-collapsible untapered core composed of longitudinally separable sections which are screwed together and into the successive sections of the shell.

Fig. 33 is a sectional plan view on line 33—33 of Fig. 32.

Fig. 34 is a detail sectional view of a corrugated core and shell, showing the preferred relation between the ribs on the core and the grooves in the shell, leaving a clear-

ance at the top of the ribs to facilitate unscrewing from the shell.

Fig. 35 is a detail perspective view illustrating a type of joint that may be used at the adjoining longitudinal edges of a corrugated shell or shell-section.

Fig. 36 is a detail side view showing a convenient method of securing on the driving core a shell having a joint of the kind illustrated in Fig. 35, using for the purpose wire bands or ties around the shell.

Fig. 37 is a detail sectional plan view on line 37-37 of Fig. 36.

Fig. 38 is a detail cross section through a joint, like that of Fig. 35, in which the socket on one edge of the shell is formed by welding to the shell one or more metal strips.

Fig. 39 is a view similar to Fig. 38 but with the socket strips riveted to the shell.

Fig. 40 is detail side view of a jointed shell, partly in section, showing a modified form of corrugation.

The tapered shell 45, illustrated in Fig. 1 for example, is composed of short lengths or sections corrugated circumferentially in screw-thread fashion. If necessary the upper end of each lower section is "belled" or enlarged enough to permit the lower end of the section next above to be screwed into it, as in Fig. 4. This gives a taper joint which is very strong and which in some cases can be made sufficiently water-tight without the use of fibrous or other packing. On the bottom of the lowermost section is a driving boot 46, screwed into place. The shell shown at 47 in Fig. 3 is similar to that illustrated in Fig. 1 except that it is untapered. Another form of joint that may be used with advantage in some cases is shown in Fig. 5, in which the upper end of the section 48 is uncorrugated and is simply belled enough to receive the adjoining end of the section above.

In practically all situations which permit of sinking the pile by means of a pile-driver a collapsible driving core may be used, preferably constructed as indicated in Fig. 1, which illustrates a core of the general type described in the prior patent of M. M. Upson and H. R. Smith, No. 1,199,722, issued September 26, 1916, to which reference is made for a complete disclosure. For the present purpose it is sufficient to say that the core comprises three segments or leaves 49, connected by radial links 50 to a central stem or rod 51. When the latter is depressed relatively to the leaves the tapered collars 52 on the rod enter the tapered three-part seats 53 on the leaves and expand the latter, holding the same firmly in outer position. Relative movement of the rod is then prevented by the pivoted shackles 54, engaging bosses 55 on the head. When these links are disengaged from the head the rod can be raised,

thereby withdrawing the collars from their seats and, through the agency of the links 50, drawing the leaves inwardly to collapsed position. The outer surfaces of the core-leaves 49 are corrugated in correspondence with the corrugations of the shell, and the driving boot 46 and the driving point 56 of the core, Fig. 1, are so proportioned that when the latter is seated in the former the outward movement of the leaves by the depression of the rod 51 to expand the core will bring the core-corrugations into accurate engagement with the shell-corrugations, thereby avoiding the injury to the shell that might be caused if the ribs on the powerfully expanding core should encounter the ribs on the shell.

The core and shell are thus locked together in what is to all intents and purposes an integral whole, the shell forming a tightly fitting skin, the corrugations of one conforming to the corrugations of the other, so that the downward pull exerted on the shell by the core as the driving proceeds is distributed around the entire circumference of the shell at each corrugation thereof.

After the shell is sunk to the desired depth the shackles 54 (see top of Fig. 1) are cast off, thus releasing the rod 51 and permitting the latter to be raised, thereby collapsing the core. This withdraws the ribs on the core from the grooves in the shell and the core can then be lifted out, leaving the shell in the ground, ready to receive the concrete.

In the construction shown in Figs. 7, 8 and 9, which is similar to that shown in Fig. 1, the central or axial rod 51^a rotates to expand and collapse the core. For this purpose it is provided with tapered collars 52^a screwing into correspondingly tapered seats 53^a. At the top the rod is equipped with a worm gear 57, meshing with a worm 58. When the worm is rotated in one direction the collars 52^a are screwed down into their seats 53^a and the wedging action thus produced expands the leaves or core-segments 49, as in Fig. 7, it being understood that the seats mentioned are each made in three parts which are secured to the respective leaves. When the rod is rotated in the opposite direction the wedge collars are withdrawn, permitting inward movement of the core-segments to collapse the core, as in Fig. 8.

In the construction shown in Figs. 10, 11 and 12 (in which a sectional untapered shell 59 is shown) the core 60 is expansible and collapsible in effect. It is in the form of a pipe equipped with a plurality of circumferential series of ribbed or corrugated blocks 61, swinging through appropriate openings in the wall of the core to engage and disengage the shell. The blocks are connected by links 62 to collars 63 on a central rod or stem 64 mounted for longitudinal

movement in upper and lower guides 65, 66, but held stationary during the driving operation by means of hooks 67 carried by the driving head 68 and engaging lugs 69 on the core. When the hooks are disengaged from the lugs the head and rod can be raised, thereby swinging the ribbed blocks 61 inwardly from engagement with the shell as in Fig. 12. The core can then be lifted bodily out of the shell. This type of core is better for driving in soft ground than in situations where great resistance is encountered. The core 70, illustrated in Fig. 13, is exactly similar except that it is tapered, for use with a tapered shell.

In Fig. 14, in which a tapered sectional shell 71 is shown, a solid core 72 is employed, having screw-thread corrugations to screw into the correspondingly corrugated shell. The core is rotatably mounted in the head 73, and can be rotated by a worm 74 meshing with a worm gear 75. To prevent rotation of the head 73 it is provided with ears 76 providing grooves adapted to align with similar grooves 77 in the hammer-base 78 and embrace the leaders or leader-extensions (not shown) of the pile-driver. By reason of the taper a few turns of the core are enough to free it from the shell-corrugations, after which it can be lifted out, as in Fig. 16, by the cables 79. The hollow core is preferably provided with numerous small openings, as 80, through its wall, and with a suitable nipple 81 for connection with a source of air, water, or other fluid under pressure, which, escaping through the openings, will tend to press the shell outwardly and thereby diminish the friction on the core, making the unscrewing operation easier. In some cases the frictional resistance may be so great as to rotate the shell along with the core, especially in wet or very soft soil. To prevent such a result the shell may be provided with lateral ears or wings, as 82, see also Fig. 17, riveted or otherwise fastened in place on the shell.

The type of core illustrated in Figs. 18, 19, 20 and 21 is designed particularly for use where the shell has to be sunk in sections, as in underpinning an existing building or other structure, but of course can be used in other situations also, and with a tapered shell if desired. As shown the core is composed of longitudinal separable sections, each divided lengthwise into two parts, as 83, 84, arc-shaped in cross section but less than a semicircle in extent so that when separated to fill the shell-section spaces will be left between the core-parts at each side. Starting with the first or lowest shell-section, the core-parts are inserted and expanded to receive the driving point, as 85, Fig. 18, which is releasably fastened by means of a pin or screw 86. The inner sleeve or pipe 87 is then inserted, provided

with longitudinal ribs 88, Fig. 21, to engage the circumferential ribs 89, Fig. 18, on the core-parts to hold the latter out against the shell section with the corrugations of the two in engagement. This sleeve or pipe 87 is of such length that its upper end is well below the top of the core when the parts are assembled, as clearly shown in Fig. 18. To arrange the next core section in place the parts of the latter are collapsed so that the flange 90 can pass the flange 91 on the rabbetted upper end of the section below, as clearly indicated in Fig. 19. The pins 92 are then inserted and the shell section is slipped down over the core, after which the next sleeve-section 87 is inserted, thereby expanding the core and bringing the flange 90 under the flange 91, as in Fig. 20. The sleeve is provided with lateral ears 93, between the adjacent edges of the core-parts, and long binding rods 94 are provided which screw into the contiguous ears on the lower section and thus serve to secure the sleeve sections firmly together. In like manner other sections of shell and core, as many as desired, are added. To remove the core after the shell has been sunk and the soil removed, the entire inner sleeve 87 is drawn out until its uppermost section is clear, whereupon the tie-rods 94 are unscrewed, permitting the sleeve section to be removed. This procedure is repeated until the whole sleeve is out of the core. An upward pull on the core will now cause the shell corrugations to cam the core-parts inwardly, and as the core sections come out of the shell the screws 92 can be removed, which allows the core sections to be separated, the driving ring 85 coming up with the last section. Or, if the pin 86 be omitted, the ring will be left in the ground.

A similar apparatus is illustrated in Figs. 22 to 24. Here the core-sections are composed of separable parts 95 provided with lateral overlapping ears or lugs 96. Two core-parts, collapsed as in Fig. 24, are assembled in the first or lowermost section of the shell 97, and then expanded to bring the corrugations of the two into cooperation, after which the longitudinal locking rods 98 are inserted into the aligned apertures in the lugs 96, as in Figs. 22 and 23. The next shell-section and core-section are then assembled and screwed into place, the upper shell-section screwing into the lower, and the threaded rabbet in the lower end of the core-section screwing down over the threaded collar on the upper end of the other core-section, as in Fig. 22. The locking rods are then inserted and screwed into the rods below. Additional sections, as many as desired, may be assembled in the same manner. To remove the core after the shell is sunk, the rods 98 are drawn out and taken apart section by section, after

which the core can be collapsed and pulled out, separating each section from the one below as it clears the shell.

Fig. 26 shows another form of core, and also illustrates the sinking of a shell by jacking down the shell and core, as under a building or other structure the bottom of which is represented by the line 99. In stage A the first section of core and shell are in place ready to be pressed down into the ground by the jack 100. In stage B the first section has been sunk and the next is in position. In stage C two sections have been sunk. In stage D three (in the present instance all that are desired) have been sunk and the core of earth in the driving core has been removed by blowing it out with an air-jet from pipe 101. In stage E the driving core has been removed and the shell 102 filled with concrete. The driving core sections 103 are uncorrugated but are provided with elongated longitudinal slots to receive correspondingly shaped movable members 104 which are corrugated to cooperate with the shell. The corrugated members being in their inner positions, as indicated in stage C, for example, the core section slips easily into the shell section, and the inner sleeve 105 is then inserted, which expands the corrugated members into engagement with the shell, as shown in Fig. 30. The core-sections and sleeve-sections are connected together by tapered screw-joints, the tapered opening in the top of the upper core-section serving to receive the driving head 106, which may also seat on a cap 107 screwed upon the upper sleeve section. After the core of earth has been removed from the driving core, as in stage D, the driving core is removed. Of course if the bottom of the shell is closed, as for example by means of a driving point, there will be no core of earth in the core when the sinking is completed. For this purpose the entire sleeve 105 is pulled up and taken apart, section by section, and lifted out, after which an upward pull on the core causes the corrugated members 104 thereof to be cammed inward, thus freeing the core and permitting it to be easily drawn out. When all the core-sections have been removed the shell is filled with concrete, as in stage E. To facilitate insertion of the sleeve-sections 105 for the purpose of expanding the core the members 104 are provided with upwardly extending beveled lugs 108, Fig. 31, which, as the sleeve enters, are engaged by the lower edge and are cammed outwardly as the sleeve continues its downward movement. To prevent the movable members 104 from falling out of the core section when the sleeve is not in place, and to prevent the lugs 108 from moving inwardly far enough to bring their upper edges into the path of the descending sleeve,

the members 104 are equipped with lateral recesses to receive studs 109 on the blocks 110, which are set in the core-section on each side of the members 104, at the top and bottom thereof, as in Figs. 28 and 29.

The driving point used on a core which is open at the lower end, as in Figs. 18, 22, 26 and 32, for example, may be in the form of a short tube 111, of relatively thin metal. When "resistance" is encountered in the form of bedrock or other impenetrable material the ring will crush down and by its cushioning effect give warning of the rock in time to prevent shattering or other damage to the costly core. If the surface of the rock encountered is sloping the ring will crush down on one side first, as indicated in Fig. 27, for example. The ring thus fits itself to the surface of the rock and seals the bottom of the shell against rapid inrush of water.

In the sectional core of simple construction shown in Figs. 32, 33, 34, the core sections 112 have bell and spigot joints, which may be of the tapered-thread type, as at 113, Fig. 34, the pitch of the threads in this joint being the same as the pitch of the corrugations of the shell. The core itself is non-collapsible, and is screwed into and out of the shell, section by section. For this purpose each section is provided with inner lugs 114, to be engaged with a suitable wrench or spanner, not shown. Fig. 34 also illustrates a relation between the core-corrugations and those of the shell, which can be employed to advantage in any of the constructions herein illustrated, particularly in those employing non-collapsible cores. As indicated, the spacing of the corrugations (from crest to crest) is the same in both core and shell, but in the former the corrugations are slightly narrower, so that when the core is driven, spaces will be left between the upper surfaces of its corrugations and the inner surfaces of the corrugations in the shell, as indicated at 115, for example. The natural compression of the ground in driving a pile tends to lock the shell against the core. In attempting to screw the core out of the shell, this friction may be so great as either to disrupt the unscrewing mechanism or to turn the whole shell around in the earth, bringing the shell up with the core. With the clearance 115 provided, the core can be lifted a sufficient distance to relieve the pressure of the shell, thereby permitting the core to be easily unscrewed.

The shell itself may be made in any convenient manner, as by bending a suitable piece of sheet steel to cylindrical or conical form, securing the edges together, and then rolling in the corrugations on a mandrel. The edges may be joined by riveting, beading, or otherwise, or they may be left free.

In the latter case it is advantageous to provide a joint such as is shown in Figs. 35, 37, 38, 39. In this construction one edge of the shell 116 is equipped with a strip 117, spaced from the shell itself by a filler strip 118, to form a socket 119 (Fig. 35) to receive the other edge of the shell, as in Figs. 37, 38, 39. The shell is then easily fitted to the core, after which it is secured by means of wire ties, as 120, Figs. 36 and 37, in which a core is shown at 121. The strips 117 and 118 can be fastened to the shell in any convenient manner, as by welding, as indicated in Fig. 38, or by rivets as in Fig. 39.

The metal of the shell may be of any suitable thickness, say from 20 to 24 gauge.

The corrugations may be of the wave type, as in the figures so far referred to, preferably about a quarter or five-sixteenths of an inch deep, and an inch or an inch and a quarter apart from crest to crest. In some cases a form of corrugation such as shown in Fig. 40 will be found advantageous. In this figure the lower face 122 is more nearly horizontal, on both the core 123 and the shell 124, thus diminishing the wedging effect of the core and correspondingly reducing the possibility of splitting the shell in driving in hard ground.

The corrugations are preferably of the screw-thread form, and we also prefer the multiple type, that is, two or more threads running parallel to each other, as this type facilitates assembly of the sections together and on the core. Generally speaking, two threads are enough, but more may sometimes be used without making the "pitch" too steep.

It is to be understood that the invention is not limited to the specific constructions herein illustrated and described but can be embodied in other forms without departure from its spirit as defined by the appended claims.

I claim:

1. Apparatus for forming concrete piles in situ, comprising a circumferentially corrugated shell of sheet metal adapted to serve as a mold for the concrete, and a driving core inside the shell, having inwardly and outwardly shiftable parts provided with circumferentially arranged corrugations to cooperate with the respective corrugations of the shell, means for shifting the core parts inwardly to free the core from the shell and permit removal of the core therefrom, and means for holding the said parts in their outer positions during the sinking of the core and shell.

2. Apparatus for forming concrete piles in situ, comprising a sheet-metal shell com-

posed of sections corrugated circumferentially in screw-thread fashion and screwed into one another, and a removable driving core inside of the shell, provided with screw-thread corrugations fitting the respective screw-thread corrugations of the shell to carry the shell into the ground with the core.

3. Apparatus for forming concrete piles in situ, comprising a circumferentially corrugated shell of sheet metal, composed of sections joined end to end, and a driving core inside of the shell, composed of sections arranged end to end inside of the shell and having inwardly movable parts provided with circumferentially arranged corrugations cooperating with the respective corrugations of the shell to carry the shell into the ground with the core, the core sections being separable from one another to permit successive removal thereof after the shell has been sunk, and means for holding the inwardly movable parts of the core sections in their outer positions during sinking of the shell.

4. Apparatus for forming concrete piles in situ, comprising a sheet-metal shell composed of sections corrugated circumferentially in screw-thread fashion and arranged end to end, and a removable driving core, provided with screw-thread corrugations cooperating with the respective corrugations of the shell to carry the shell into the ground with the core.

5. Apparatus for forming concrete piles in situ, comprising a shell of sheet metal composed of sections joined end to end and corrugated circumferentially in screw-thread fashion, and a driving core inside of the shell composed of sections arranged end to end inside of the shell and having inwardly movable parts provided with screw-thread corrugations cooperating with the respective corrugations of the shell to carry the shell into the ground with the core, the core sections being separable from one another to permit successive removal thereof after the shell has been sunk, and means for holding the inwardly movable parts of the core sections in their outer positions during the sinking of the shell.

6. Apparatus for forming concrete piles in situ, comprising a sheet metal shell composed of circumferentially corrugated sections arranged end to end, and a removable driving core inside of the shell, having corresponding circumferential corrugations fitting the respective corrugations of the shell to carry the shell into the ground with the core.

In testimony whereof I hereto affix my signature.

MAXWELL MAYHEW UPSON.