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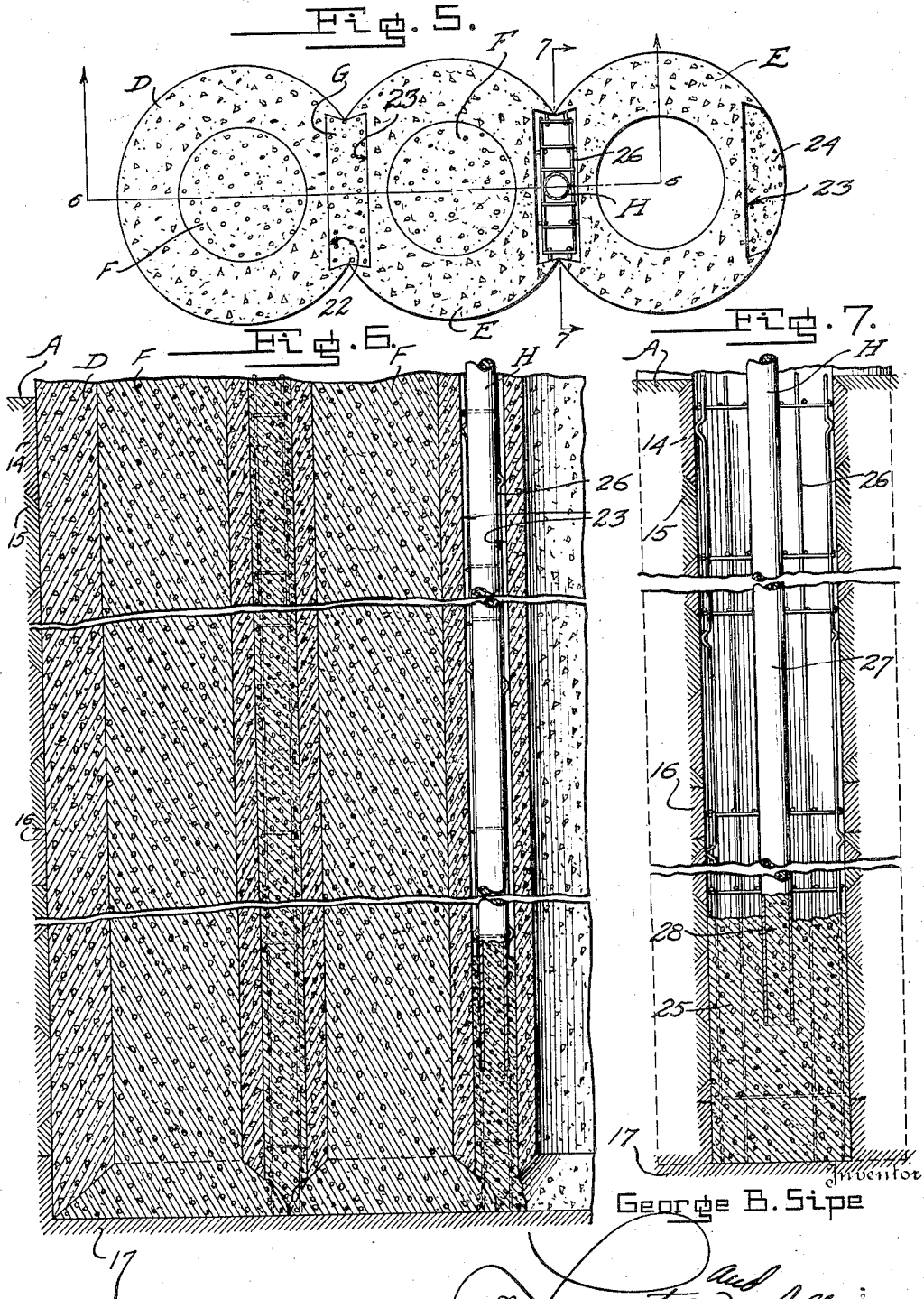
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3 Sheets-Sheet 2



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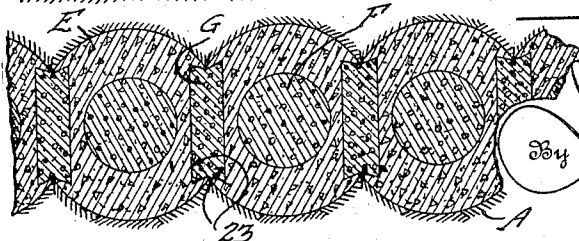
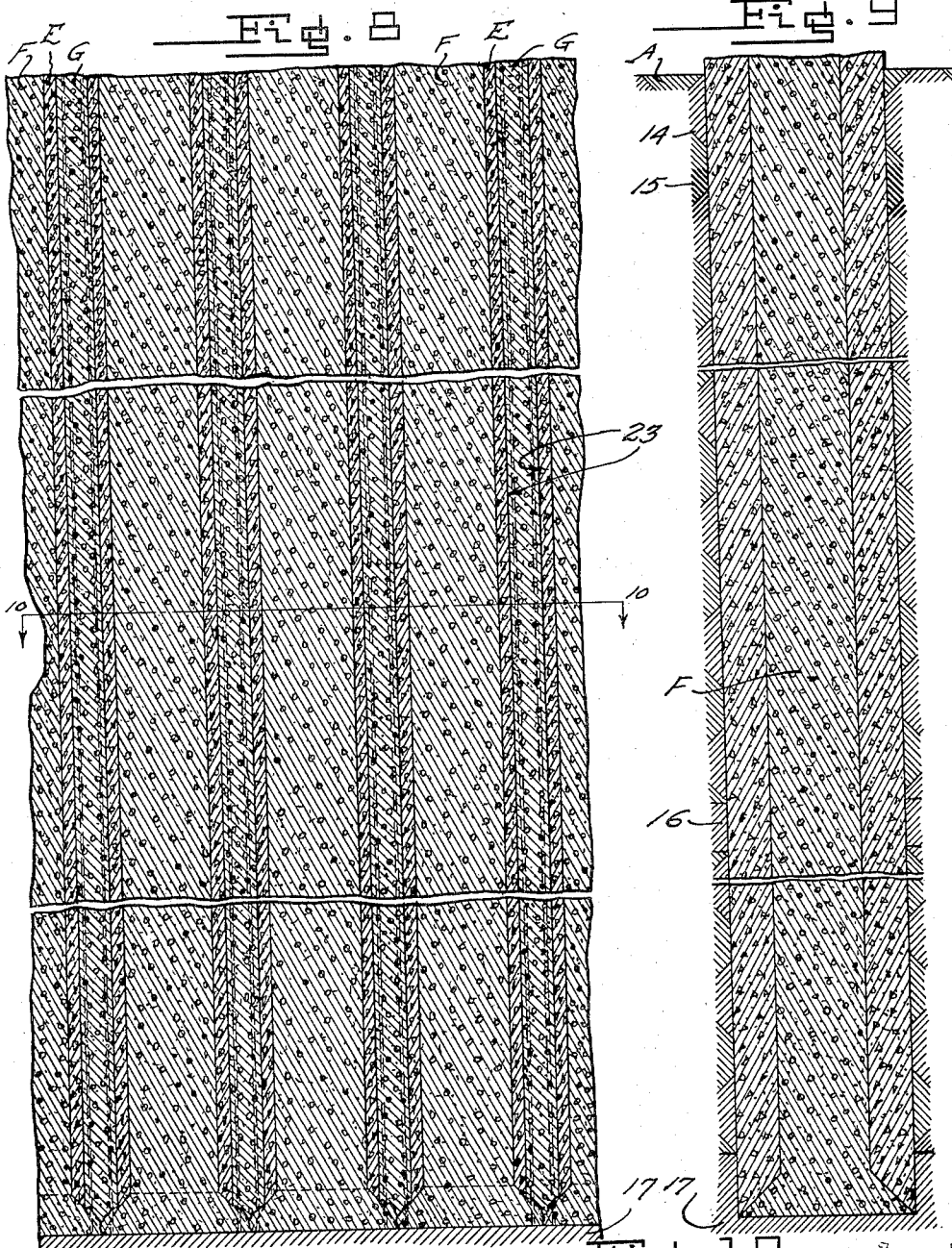


Fig. 10. Inventor
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UNITED STATES PATENT OFFICE.

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METHOD OF PRODUCING AND PLACING PILES IN INTERLOCKED RELATION.

Application filed April 22, 1925. Serial No. 25,067.

The present invention relates to a method whereby piles of cementitious material, such as concrete, and of considerable cross section, may be produced in place and in firm interlocked relation, in contradistinction to reinforce concrete sheet piles of the character intended to be driven into place or sunk by water-jet methods, and which sheet piles are necessarily of limited cross section, and limited as to depth of penetration. The present invention is also distinguished, in a similar manner, for sheet metal piling or cast metal piling with marginal portions of each pile arranged for interlocking relation with adjacent piles and relatively thin intervening webs of metal.

The principal object of the present invention is to provide a method for producing piles in interlocked relation so that they may form an integral part of substructures of every character, but particularly those that extend below the water line to any desired or required distance.

Another object of the invention is to provide a method of producing piles so interlocked in juxtaposed relation and extending into rock or other hard formation that they may form an absolutely water tight coffer-dam which will serve as a permanent wall for sub-basement stories and which may have their extreme basement floor upon the solid base of hard rock, or at any predetermined level above the same.

Another object of my invention is to provide a method of producing spaced apart walls or interlocked piles between which any desired material may be placed and retained against the action of water, such as in the production of a causeway, pier or the like.

A further object of the invention is to provide a method whereby these walls of interlocked piles may be cross connected and interlocked by wall structures of similar character so as to add to the strength and stability of the final structure, or series of interlocked piles arranged in any desired angular relation to one another, thus providing a method the efficacy of which will be very apparent to the builders of sub-basement stories of buildings, hydro-electric plants or other compartment substructures below the water level.

A further object of the invention is to provide a method which avoids the waste incident to the placing of units which only temporarily perform a useful purpose, such as

sheet piling, or the necessity of salvaging such in an effort toward economy, the piling of cementitious material in interlocked relation having a dual function,—a barrier to water and caving-in of earthy formation whole construction work is being carried on, and an integral part of the completed structure.

Another object of the invention is to provide a coffer-dam of interlocked piles of sufficient strength to be self sustaining against all lateral pressure, thus eliminating the use of waling and shoring and the consequent expense of placing and removing such aids necessarily employed by the usual methods of constructing and operating coffer-dams.

Another object of the invention is to provide a method that eliminates the element of risk which attend other methods in unforeseen difficulties that may be occasioned by the caprices of nature. For instance, bed rock may be within reach of the pneumatic caisson method for every caisson except one in the construction of the foundation for a modern structure, or a boulder may lie directly in the path of a series of driven sheet piling or piling being sunk by jetting. In either of these cases added expense would necessarily attend the mastering of the difficulties thus occasioned. The element of risk to human life is ever present in closed caisson work.

In practicing the present method, some of the steps disclosed in my copending applications for patents entitled Method of producing and placing piles, filed October 26, 1923, Serial No. 671,015 and Method of producing and placing shafts, piles and the like, filed April 15, 1925, Serial No. 23,349, may be resorted to. In my said copending applications are disclosed methods whereby piles of large diameter and of any desired shape and length may be produced and placed in or through each and every formation, under any reasonable conditions, with accuracy, certainty and dispatch. Also, in my copending applications for patents entitled Drill bit blade constructions filed November 8, 1923, Serial No. 673,584 and Combined drill and under reamer, filed April 15, 1925, Serial No. 23,350, are shown apparatus which may be conveniently used in the production of cavities in which pile casings may be primarily placed in or through the various strata encountered beneath the lands surface, or beneath the sea or other body

of water. Reference will be made to these applications hereinafter, but it is to be distinctly understood that such are merely by way of example since conditions concurrent with the adoption of the present method will necessarily vary, and changes in the sequence of steps taken may be resorted to, or steps omitted when required, and different apparatus used for drilling the cavities without sacrificing advantages of the present method.

In the accompanying drawings:

Figure 1 is a vertical sectional view through two next adjacent pile casings, parts being broken away and removed to condense the view, one casing being shown in place and the other being placed, following a rotary drill which is shown in elevation.

Figure 2 is a plan view of the pile casings shown in Figure 1 and the drill stem in cross section.

Figure 3 is a cross sectional view, at a reduced scale, on the line 3—3 of Figure 1, the position which the next adjacent pile casing will assume, being shown in dot and dash lines.

Figure 4 is a cross sectional view through two placed adjacent pile casings.

Figure 5 is a plan view of two completed piles in interlocked relation and a third pile casing in the course of being interlocked to one of the completed piles.

Figures 6 and 7 are vertical sectional views on the lines 6—6 and 7—7, respectively, of Figure 5, adjacent soil strata being also shown in section and some of the equipment in elevation.

Figure 8 is a central vertical sectional view through a series of completed piles in interlocked relation.

Figure 9 is a similar view through one of the completed piles in a vertical plane at right angles to the plane of Figure 8.

Figure 10 is a cross sectional view on the line 10—10 of Figure 8.

Figure 11 is a plan view of completed piles in interlocked relation, only fragments of some being shown, but disclosing the manner in which a plurality of piles may be directly interlocked with one pile as would occur at a corner of series of interlocked piles.

Throughout the several views like characters designate similar or corresponding parts or characteristics thereof.

A designates generally earthy matter at the site where construction takes place; B suitable apparatus for forming a cavity C in the earthy matter A; D a suitable casing which, by way of example may be used when starting the construction work; E a suitable pile casing of the character used intermediate adjacent pile casings; F a filler for the casings D and E so as to form solid piles; G a filler or key for retaining the casings or

piles in interlocked relation; and H suitable apparatus which may be used to facilitate the placing of the filler G.

The present method is equally well adapted to use where a body of water overlies the earthy matter A into which the piles in interlocked relation are to be disposed, as where water prevails only beneath the earth's surface, or where no water is encountered in any appreciable quantity. Reference may be had to my aforesaid copending applications for patents Serial No. 671,015 and Serial No. 23,349 wherein approved procedures are disclosed for the purpose of sinking pile casings into the earthy matter which may exist below a body of water. It suffices, in the present case to illustrate and describe an example where water prevails only beneath the earth's surface.

The earthy matter A may be of ordinary soil 14, such as sand and clay, or combinations thereof as loam, gumbo, etc., quicksand 15 or other strata of flowing character where considerable water prevails, rock 16 of relatively thin character, frequently encountered when penetrating the earth's surface and not sufficiently thick to sustain a load of any considerable magnitude, and bed rock 17 or other hard formation impervious to water.

Reference may be had to my aforesaid copending applications Serial No. 673,584 and Serial No. 23,350 in connection with suitable apparatus designated B, for producing the cavity C in the earthy matter A. It suffices to state that this apparatus may comprise a hollow drill stem 18, drill collar 19, and carriers 20 for removable blades 21. The cutting capacity of a drill may be increased or diminished at will, by the addition or removal or substitution of different sizes of blades 21. It is to be understood that a rotary motion is imparted to the drill stem 18 and parts carried thereby, and that mud is preferably pumped and forced down inside the drill stem 18, to be directed through the collar 19 to impinge against the blades, thereby assisting in disrupting, dissolving and carrying upwardly particles broken off by the drill, the mud flowing upwardly at the outside of the drill stem and having egress from the cavity C at the upper end thereof.

While it is not essential that the pile casing D or D' initially placed differ materially from those casings designated by character E, it is preferred that the starting pile casing have one or more longitudinally extending keyways 22 open at the outside of the casing. If such casing D has more than one key way, it is preferred that these be in angular relation to one another, instead of diametrically opposite, as shown in Figure 11, where the starting pile casing D' is intended for use at a corner of two series of

piles in angular relation to one another. The intermediate pile casings, in the example shown, are provided with diametrically opposite longitudinally extending guideways 23 although it is to be understood that these guideways need not necessarily be diametrically opposite, since the method is applicable where the adjacent piles are arranged in irregular formation, or in circular or oval alignment. Furthermore it is not essential that these be cylindrical in shape or of any specific material. The casings are preferably of plain or reinforced concrete and may be of any approved shape in cross section, thickness of walls, and built up integral en masse or in sections suitably joined either longitudinally or transversely, or both. The keyways 22 and 23 may be of any approved shape and size, and in the example shown are of the well known "dove tail" cross section, so that when the filler or key G is placed, such will prevent movement of one pile with respect to the other, both laterally and longitudinally of the general line of formation. It may be desirable to make the key-ways relatively smaller where laterally extending walls join the main wall, and it is to be distinctly understood that the size and shape of these key ways, and particularly their depth, as shown in the official drawings, is merely by way of example.

The filler F may also be of any suitable material, such as plain or reinforced concrete, or if desired, sand, gravel, or other material may be used without departing from the spirit of the present invention.

In order to facilitate assemblage and proper alignment of one pile casing with respect to another, the keyways 22 and 23 may be provided, at their lower end portions, with frangible closures 24, which are preferably shaped to conform to the general outer contour of the casing. The functions and advantages of these fillers will be more fully hereinafter set forth.

In the example shown, the filler or key G is shown as comprising a mass of concrete 25, with suitable reinforcements 26. This is, however, by way of example, for any suitable filler or key may be used, preferably of that character impervious to water. While the filler or key G may be placed in any approved manner, it may well be disposed in place by use of apparatus such as is shown in my aforesaid copending application Serial No. 23,349 in which connection reference may be had to Figures 5, 6 and 7 of the drawings, where the apparatus H includes a conductor tube 27 for the concrete 25 or other cementitious material, the lower end of the conductor tube being shown embedded in the mass of material 25, which has not become set, and the filling progresses upwardly, a column 28 of cementitious material being maintained in the conductor tube 27 un-

til the communicating keyways have been filled to the desired extent, preferably from in the bed rock or other hard formation 17, impervious to water, upwardly to the desired level.

When bringing the method into practice, a starting pile casing, such as that designated D or D' is initially sunk into the soil, preferably to extend into the bed rock 17 or other hard formation. This may be accomplished by use of the drill apparatus B, the casing to follow the drill as it penetrates the earthy matter. In the example shown in Figures 1, 2 and 3, the earthy matter disrupted by the drill, and the mud used to facilitate drilling cannot enter, to any appreciable extent, the key way 22 inasmuch as the frangible closure 24 is disposed at the lower end of the keyway. After the initial pile casing has been placed, it may either be completed into a form of a solid pile, by introduction of the filler F, or this may be accomplished at a later period. A second cavity C is drilled next adjacent to the casing thus placed, and the drill is so arranged that it follows a path which intersects the drill path taken in producing the first mentioned cavity, at the keyway 22 of the casing already placed. In this connection, reference may be had to Figure 3 in which the path of the next adjacent casing to be placed, is indicated by dot and dash lines. In Figure 2 it will be observed that the blade carriers 20 are in a path which intersects the drill path taken in producing the cavity in which pile casing D' is disposed.

The intermediate or second pile casing E is permitted to follow the drilling apparatus as it penetrates the earthy matter A next adjacent to and in contiguous relation to the casing D or D' which has been placed as is shown in Figure 1. The keyways 23, being provided with fillers 24 of frangible material, not only prevent passage of considerable quantities of matter disrupted by the drill, into the keyways, but that filler next adjacent to the pile casing already placed, serves as a guide, sliding as it does in the keyway 22. In operation of the drilling apparatus B, the drill has an inherent tendency to take a path closely adjacent to the pile casing already placed, because of the portion of the cavity C, devoid of hard matter, at the keyway of the placed casing providing a path of least resistance. The filler 24 prevents lateral movement of the lower portion of the hollow casing with respect to that casing which has been placed and as the drilling progresses, and reaches the filler 24 of the casing already in place, the drill penetrates such frangible filler thus providing a way for the filler 24 of the casing being placed. It is preferred to sink the casings to a depth in the bed rock that the fillers 24 will be below the upper surface of

said bed rock or other hard formation, impervious to water so that when a filler or key G is used for retaining the piles in interlocked relation, and such material making up the filler or key G is also impervious to water, a coffer-dam, or retaining wall, through which no water may pass, can be provided, the advantages of which will be readily apparent with those skilled in the art.

It is desirable to emphasize that the series of piles in interlocked relation and in wall like form may be of such magnitude as to be self sustaining against lateral pressure if material is removed from a portion of one side of the wall, as would be the procedure in excavating for basement and sub-basement floors of a building or other structure having compartments beneath the water level. The piles may be produced and placed in interlocked relation before any excavation to either side of the building line on the site, takes place, and may be rendered so impervious to water, as by their penetration into bed rock or other hard formation, and the use of a filler also impervious to water, as an interlocking medium, that little or no water-proofing is required after excavation takes place laterally of the wall or coffer-dam thus formed in order to carry on other construction work adjacent same or render space habitable where excavation has taken place.

I claim:

1. Those steps in the method of producing and placing piles in interlocked relation which comprises, drilling a cavity into the soil, placing a casing having a longitudinally extending keyway open at its side, in the cavity, drilling a second cavity next adjacent to the casing thus placed, so that the path taken by the drill intersects the drill path taken in producing the first mentioned cavity at said keyway, and placing a second casing in said second cavity in contiguous relation to said first mentioned casing.

2. Those steps in the method of producing and placing piles in interlocked relation which comprises, drilling a cavity into the soil, placing a casing having a longitudinally extending keyway open at its side, in said cavity, drilling a second cavity next adjacent to the casing thus placed, so that the path taken by the drill intersects the drill path taken in producing the first mentioned cavity at said keyway, placing a second casing in said second cavity in contiguous relation to said first mentioned casing and with a keyway open to said first mentioned keyway, and disposing a key in said keyway.

3. Those steps in the method of producing and placing piles in interlocked relation which comprises, drilling a cavity into the soil, placing a casing having a longitudinally extending keyway open at its side, in

the cavity, drilling a second cavity next adjacent to the casing thus placed, so that the path taken by the drill intersects the drill path taken in producing the first mentioned cavity at said keyway, placing a second casing in said cavity in contiguous relation to said first mentioned casing, and placing a mass of cementitious material in said keyway.

4. Those steps in the method of producing and placing piles in interlocked relation which comprises, drilling a cavity through the soil and into bed rock or other hard formation impervious to water, placing a casing having a longitudinally extending keyway in the cavity with the casing and said keyway thereof terminating in the bed rock or other hard formation, drilling a second cavity next adjacent to the casing thus placed thru the soil and into bed rock or other hard formation impervious to water, so that the path taken by the drill intersects the drill path taken in producing the first mentioned cavity at said keyway, placing a second casing having a longitudinally extending keyway in said second cavity in contiguous relation to said first casing and with the second casing and the keyway thereof terminating in the bed rock or other hard formation and with said two keyways communicating, and placing a filler impervious to water in said communicating keyways from their terminals in the bed rock or other hard formation upwardly to any desired or required level.

5. Those steps in the method of producing and placing piles in interlocked relation which comprises, placing a casing, having a longitudinally extending keyway, open at its side, in the soil, drilling a cavity next adjacent to said casing with the path of the drill extending into said keyway, and lowering a second and hollow casing in the cavity, to follow with the drill, and in contiguous relation to said first mentioned casing.

6. Those steps in the method of producing and placing piles in interlocked relation which comprises, drilling a cavity into the soil, placing a casing in the cavity to follow as the drilling progresses, said casing having a longitudinally extending keyway open at its side and closed at its bottom by a frangible closure, drilling a second cavity next adjacent to the casing thus placed, so that the path taken by the drill intersects the drill path taken in producing the first mentioned cavity, at said keyway, the drilling proceeding through said frangible closure, and placing a second casing in the second cavity to follow as the drilling progresses, said second casing having a longitudinally extending keyway open at its side and provided with a closure at its bottom and said keyways intercommunicating with

the closure of said second keyway sliding in said first keyway and guided by said first casing as the second casing descends.

7. The method of producing and placing
5 piles in interlocked relation, which comprises the drilling of a cavity into the soil and placement of a hollow casing in the cavity to follow in the cavity as the drilling progresses, the casing having a longitudi-
10 nally extending keyway exteriorly thereof, drilling a cavity next adjacent to said casing with the path of the drill partially ex-

tending into said keyway during the drilling operation, and lowering a second hollow casing in the last mentioned casing to follow as the drilling thereof progresses, the last mentioned casing having a keyway exteriorly therein facing the keyway of the first mentioned casing, and subsequently filling said keyways with cementitious material to provide an interlocking key for
20 said hollow casings.

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