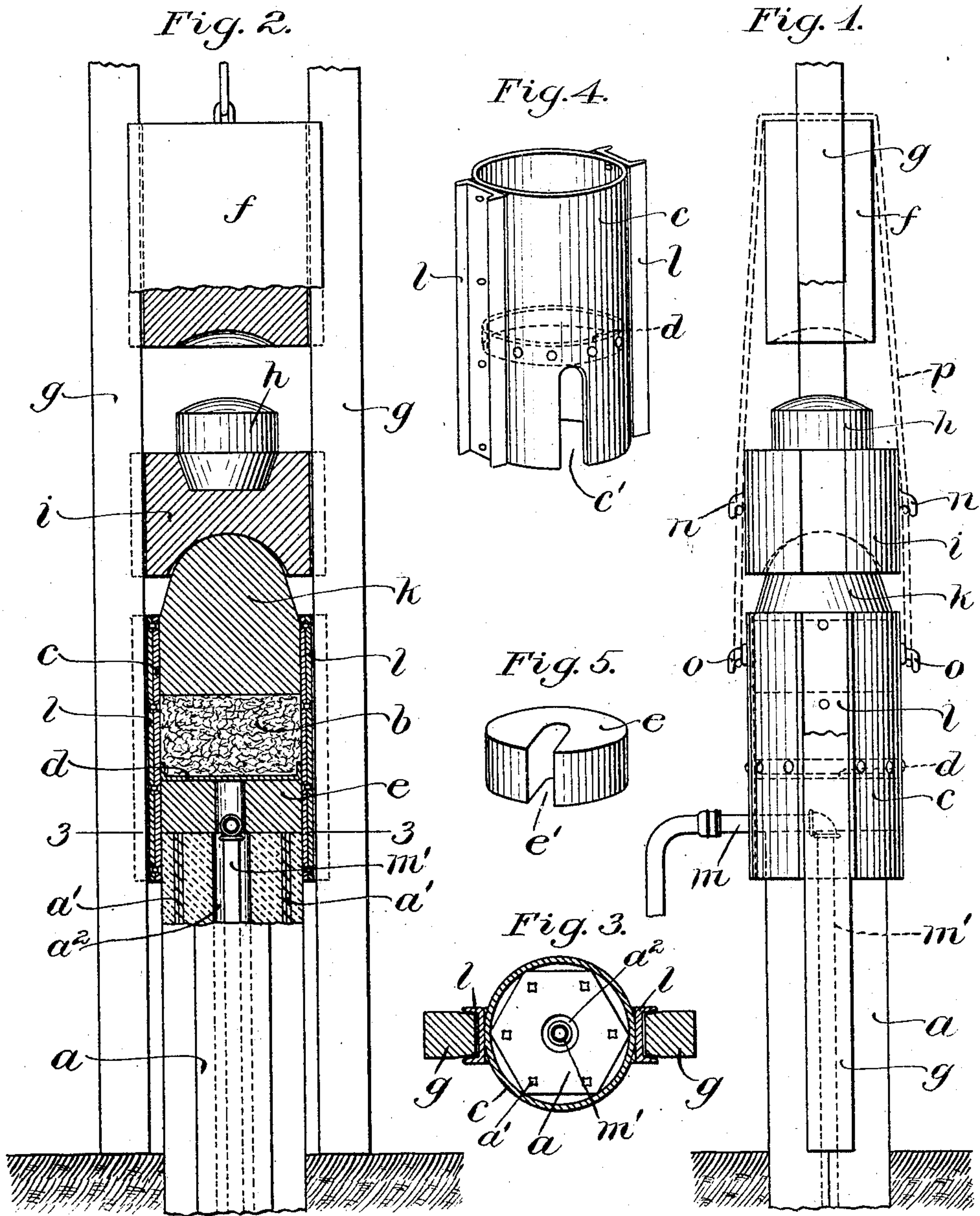


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METHOD AND APPARATUS FOR SINKING CONCRETE PILES.  
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Patented Feb. 9, 1909.



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# UNITED STATES PATENT OFFICE.

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## METHOD AND APPARATUS FOR SINKING CONCRETE PILES.

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Specification of Letters Patent.

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*To all whom it may concern:*

Be it known that I, FRANK B. GILBRETH, a citizen of the United States, residing at Brookline, in the county of Norfolk and State of Massachusetts, have invented an Improvement in Methods and Apparatus for Sinking Concrete Piles, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to the sinking of piles and more particularly, though not exclusively to piles formed wholly or partially of concrete with the object of performing the sinking thereof expeditiously and without injury to the structure of the pile.

My invention will be best understood by reference to the following description when taken in connection with the accompanying illustration of one specific embodiment thereof while its scope will be more particularly pointed out in the appended claims.

In the drawings,—Figure 1 is a side elevation, partially broken away, showing a portion of one form of apparatus employed in carrying out my invention; Fig. 2 shows a vertical central section of the apparatus shown in Fig. 1; Fig. 3 is a section in plan on the line 3—3 in Fig. 2; Fig. 4 is a perspective of the casing shown in Fig. 1, and Fig. 5 is a perspective of the spacing block.

In the drawings *a* represents the upper end of a concrete pile, which may be of any suitable form, shape or construction, but which I have here shown as hexagonal in cross-section, reinforced by the six longitudinal reinforcing rods *a'* of twisted steel and provided with a central jetting passage *a''* formed in the molded body of the concrete and extending throughout the length of the pile to the lower end thereof, which latter is not shown. Concrete piles of this or other constructions may be sunk wholly by ramming or driving, or wholly by the use of a water jet discharging at the lower end of the pile and acting to displace the earthy matter and carry it about the sides of the pile, thus causing the sinking of the latter. The apparatus which I have here disclosed, however, is particularly designed for carrying out a combination of these two methods, the sinking by means of the water jet being supplemented by driving or ramming, or other forcing means at the pile head, and it is this method which I pre-

fer in practice to carry out. It is to be understood, however, that my invention is not limited to the sinking of piles by the combined effect of the forcing and jetting devices, but that it is applicable in many features to the sinking of piles by ramming or forcing alone and, in others to the sinking of piles by jetting alone.

In the driving of concrete piles much care must be exercised to avoid the fracture of the pile body. In the illustrated embodiment of my invention I have surmounted the pile with a body of cushioning material *b*, which is adapted to compress under the blow of the pile hammer and through this cushion the hammer blow is transmitted to the head of the pile, preventing injury thereto. This cushioning body may be of any suitable material but is preferably of shavings, sawdust, rubber scrap or other similar and suitable loose cushioning material, each of which may be used alone, but which for the best results should be combined in whole or in part. The cushioning material is held within the casing *c*, herein of sheet metal and herein, though not necessarily, cylindrical in form. The cushioning material rests upon a fixed diaphragm or wall *d* within the casing and the latter is supported upon the head of the pile by the said diaphragm through the interposition of the spacing block *e*.

The hammer *f* slides in suitable guides *g, g*, mechanism for raising and dropping the same being of any suitable or usual type, and not herein shown. When the hammer drops it strikes the wooden cushion block *h*, which is seated in the follower *i*. The latter is preferably of metal and rests upon the plunger member *k*, which is preferably of wood and slidable in and out of the upper open end of the casing *c* and is supported upon the cushioning body *b*. Both the follower *i* and the casing *c* engage the vertical guides *g, g*, the latter for this purpose being provided with the channel irons *l*, riveted to the outside of the casing. This causes the casing with its contained parts as well as the follower which rests thereon, to descend with and upon the pile and in alinement therewith as the latter is sunk. The walls of the casing extend below the wooden space block and loosely embrace the head of the pile so that the one is located and aligned relatively to the other.

It will be seen that the construction of the



protecting device described does not necessarily require the casing to fit the pile head with any degree of approximation and in fact a single casing may be used upon piles  
 5 of widely varying diameter. I prefer, however, to construct the casing approximately to fit the pile head for, by so doing, the pile is not only maintained in alinement with the direction of the hammer blow but is accurately guided through engagement of the  
 10 closely fitting casing with the guides *g* in the direction in which it is intended to be sunk. This is an important advantage particularly where the water jet is resorted to either as  
 15 a principal or as a cooperating sinking means. Where it is desired to make use of a single casing for piles of different diameter, the object may still be achieved by the use of an adapter. Another advantage of the illustrated construction of protecting device lies  
 20 in the fact that the cushioning material being effectively retained irrespective of the fit of the casing upon the pile head, it may be applied indiscriminately to piles of irregular section, such for example as the hexagonal pile illustrated, or to corrugated  
 25 piles, or piles of other non-circular cross-sections, without sacrifice of effectiveness.

To assure the stability of the apparatus and the alinement of the parts intervening  
 30 between the pile and the hammer, I have provided means to cause the reception of the hammer blow centrally upon the plunger *k*. For this purpose the upper part of the  
 35 plunger is given preferably an approximately spherical shape and fits into a corresponding recess preferably of slightly greater curvature on the under side of the follower. This  
 40 tends to centralize the blow along the axis of the plunger, even should the follower or the plunger be slightly out of alinement. To further insure the central delivery of the  
 45 hammer blow I have rounded the top of the cushioning block *h*, and the face of the hammer where it strikes this block is correspondingly cupped.

The spacer block *e*, which is preferably of wood, is cut away or slotted vertically at *e'*  
 50 to provide a space for the insertion of the water jet pipe *m* between the cushioning body and the pile, the casing *c* being also cut away at *c'* to clear the pipe. The jetting  
 55 pipe *m* is connected with any suitable source of water supply under pressure and has the down-turned branch *m'* entering the jetting passage *a*<sup>2</sup> and extending to the lower end of the pile.

In operation the pile after being placed in position is driven into the ground by the  
 60 hammer *f*, which delivers its repeated blows through the cushion block *h* to the follower *i*. From the latter they are transmitted to the pile through the plunger *k*, cushioning body  
 65 *b*, diaphragm *d* and block *e*, the cushioning body, at each blow of the hammer, yielding

sufficiently under the plunger *k* to cushion the blow and prevent injury to the pile. The cushioning material being held between the stationary wall formed by the diaphragm *d* and the movable wall formed by the plunger  
 70 *k*, does not come in contact with the pile and is retained in place without the need of packing, the cushion yielding without necessary movement of the casing *c* upon the pile. The employment of the wooden block *e*, as well as  
 75 the wooden plunger block *k*, and the cushion block *h*, interposes a considerable mass of solid semi-elastic cushioning material between the head of the pile as well as the  
 80 loose cushioning material *b*, increasing thereby the protection to the pile against fracture and the likelihood of a direct central delivery of the blow. During the driving of the pile, water is freely admitted under pressure  
 85 through the pipe *m* and, forming a high pressure jet at the foot of the entering pile, renders the sinking thereof an easy and rapid operation. The water discharged at the advancing foot of the pile loosens the earth and  
 90 carries the subdivided earthy particles upward to the surface at and about the sides of the pile, progressively excavating the material in advance of the pile and the upward stream acting as a lubricant, so to speak, to  
 95 assist the settling of the pile. In practice I have found that concrete piles of thirty or more feet in length may be sunk under favorable conditions in about twenty minutes by the combined use of the water jet and the  
 100 hammer. The puddling action of the water upon the earth adjacent the sides of the pile is highly beneficial in giving the latter a firm adherence to the adjacent soil, for, when left to harden, the wet earth settles closely in  
 105 and about the sides of the pile.

In order to permit the easy withdrawal from the pile of the follower, with or without the casing and its contents, I have provided the follower with means comprising hooks *n*,  
 110 and the casing with hooks *o* by which the same may be attached to the hammer, as by means of the rope *p* shown in dotted lines in Fig. 1, and thereby lifted away from the pile with the hammer.

My invention so far as it comprehends the  
 115 sinking of a pile through the use of a water jet assisted by other means, is not of course limited to the usual ramming of the pile by the ordinary pile driving apparatus, although  
 120 with the described means for protecting the pile such ramming may be employed without danger of fracture or other injury to the concrete. It is within my invention to employ means for assisting the water jet other than  
 125 a hammer, such for example as the steady downward pressure afforded by hydraulic or other pressure applied to the head of the pile or a large weight applied to and resting thereon.

While I have illustrated and described 130



with particularity one form of my invention, it should be understood that the same is submitted wholly for illustrative purposes and that extensive modifications may be made in the details and procedure described without departing from the spirit of my invention.

#### Claim.

1. Pile sinking protecting means comprising a casing, cushioning material within said casing and a plunger member movable within the casing above the cushioning material to receive the hammer blow.
2. Pile sinking protecting means comprising a casing, cushioning means within said casing and relatively movable means within said casing for transmitting the hammer blow to the cushioning means.
3. In a pile sinking protecting device, the combination with a casing, cushioning means within said casing, a stationary wall on one side thereof and a movable wall at the other side.
4. A pile protecting device having a cushion both of solid and loose cushioning material to protect the pile from the blow of the hammer.
5. The combination with a concrete pile having a non-circular cross-section, head forcing means and jetting means and cushioning means therefor, said cushioning means being applicable to the non-circular heads of piles of varying size and different cross-sectional shapes.
6. The combination with a concrete pile, of a pile driving hammer and a cushion of loose material and a cushion of solid material between the pile and the hammer.
7. In a pile sinking protecting device for concrete piles, a cushion holding casing having a cushion support for supporting the same upon the head of the pile, said support being yieldable relatively to the material of the pile.
8. In a pile sinking protecting device the combination with a casing, cushioning material within said casing and a wooden plunger block above said cushioning material.
9. In a pile sinking protecting device, means for delivering a cushioned blow to the head of the pile comprising a cushion, a member resting upon said cushion to receive the blow and means for maintaining the alignment of said cushion and of said member.
10. In a pile sinking protecting device, cushioning means, a member upon said cushioning means to receive the hammer blow and means for centralizing the blow upon said member.
11. In a pile sinking protecting device, the combination with a cushion and a member upon said cushion to receive the hammer blow, of means for centralizing the blow delivered to the pile through said cushion.
12. In a pile sinking device the combination, with a hammer of a cushion of loose

material between the hammer and the head of the pile and a wooden cushioning member also between said hammer and pile.

13. In a pile sinking device, the combination with a cushioning member of a hammer and a follower between said hammer and said cushioning member.

14. In a pile sinking device, the combination with cushioning means, a member adapted to transmit the hammer blow to said cushioning means and a follower to transmit the hammer blow to said member.

15. In a pile sinking device, cushioning means, a member for transmitting the hammer blow to said cushioning means and a self-centering follower engaging said hammer.

16. The combination with a pile of cushioning means, a block above the cushioning means to transmit the hammer blow and means to maintain the block, cushioning means and pile in alignment.

17. The combination with a pile of a casing, cushioning means, a follower and hammer, and means for delivering the hammer blow centrally of the pile, the follower and the cushion.

18. In a pile sinking apparatus the combination with pile driving means, means for interposing a cushion between the driving means and the head of the pile, and means for entering water through the head of the pile.

19. A pile sinking apparatus having a casing adapted to rest upon the head of the pile, a cushion within said casing and water jetting means between the cushion and the head of the pile.

20. A pile driving apparatus having a casing adapted to be supported by the head of the pile, cushioning means within said casing and a wooden member between said cushion and said hammer.

21. Pile sinking protecting means comprising a body of loose cushioning material, a casing confining the same, a relatively unyieldable member adapted to be placed between the cushioning body and the head of the pile to hold the former out of contact therewith, said member being recessed to permit the connection of a lateral jetting pipe with the pile interior.

22. Pile sinking protecting means comprising an open-ended casing adapted to be placed upon the head of a pile, a movable plunger in said open end, and cushioning material within said casing beneath said plunger.

23. A pile sinking protecting device having a casing adapted to be placed upon the pile head, said casing having means for confining a body of loose cushioning material and holding the same out of contact with the pile head.

24. In a pile sinking protecting device the



combination with a casing adapted to rest loosely upon the head of a body of loose cushioning material within said casing, said casing having a chamber for said cushioning material closed against the exit of said material at the bottom thereof.

25. A pile sinking protecting device having a casing adapted to be loosely held upon the head of the pile, a yielding cushion to receive the hammer blow and a relatively unyielding member to support the casing upon the pile.

26. The combination with a molded concrete pile provided with a jetting passage molded therein for passing water centrally through the pile, of pile sinking apparatus comprising pile-forcing means and jetting means, the latter operative during the sinking of substantially the entire pile.

27. The combination with a molded concrete pile having a longitudinal jetting passage molded therein and extending substantially the entire length of the pile, of pile-driving apparatus comprising means for forcing the head end of said pile.

28. The combination with a molded pile having a composite body of concrete and metal for substantially its entire length and provided with an interior jetting passage molded therein, of means for introducing a jetting stream of water to the pile interior, and means also for forcing the head of the pile.

29. A pile protecting device for concrete piles comprising a casing provided with means for supporting it loosely on the head of the pile, a body of loose cushioning material within the casing, and a member resting above the cushioning material and movable relatively to the casing to transmit the hammer blow to the pile through the cushioning material.

30. A pile protecting device for concrete piles comprising a casing adapted to rest loosely upon the head of the pile, an interior transverse partition wall for supporting said casing thereon, loose cushioning material above said partition wall, and a plunger movable relatively to said casing above the cushioning material for transmitting thereto the hammer blow.

31. In a pile sinking apparatus the combination of a casing having an open lower end adapted to fit loosely over the head of a pile, said casing being provided with an interior supporting wall adapted to sustain the same upon said pile, a spacing block between said wall and the head of the pile, a body of loose cushioning material above said supporting wall, and a plunger block resting upon said cushioning material movable within said casing and adapted to transmit to the pile through the cushioning material the blow of the hammer.

32. In a pile protecting device the combi-

nation with the casing *c*, the wall *d*, cushion *b*, and plunger block *k*.

33. In a pile sinking apparatus the combination with the casing *c*, the cushion *b*, the wall *d*, and the block *e*.

34. In a pile sinking apparatus the combination with a cushion *b*, the casing *d*, and the jetting pipe *n*.

35. The method of sinking a pile which consists in forcing the upper end thereof, cushioning the forced end and also introducing water through the forced end.

36. The method of sinking a pile which consists in conducting water to the interior of the pile and the leading end thereof and there forming a jet to sink the same, simultaneously forcing the head end of the pile, suitably cushioning the forced end thereof and continuing the jetting operation until the sinking of the forced head end is substantially complete.

37. The combination with a molded pile having a composite body of concrete and metal for substantially its entire length and provided with an interior jetting passage molded therein, of means for introducing a jetting stream of water to the pile interior, means for forcing the head of the pile, and means for cushioning the forced head end thereof.

38. In a pile sinking apparatus, the combination with jetting means and pile-forcing means, of means for interposing a cushioning of loose material between the pile and the said forcing means.

39. In a pile sinking apparatus, the combination with pile-forcing means, of jetting means operative during the sinking of substantially the entire pile for passing water centrally through the sunken portion thereof, and means for interposing a suitable cushion between the forcing means and the head of the pile.

40. In a pile-driving apparatus, the combination with a pile having a longitudinal jetting passage extending substantially the entire length of the pile and within the same, of means for forcing said pile, and means for interposing suitable cushioning between the forcing means and the head of the pile.

41. The combination with a concrete pile having a non-circular cross-section, of a cushioning device therefor provided with loose cushioning material, said cushioning device being applicable to the non-circular heads of piles of varying size and different cross-sectional shapes.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

FRANK B. GILBRETH.

Witnesses:

EDITH E. CHAPMAN,  
THOMAS B. BOOTH.