G. A. BEHRND.

METHOD OF MAKING PILES.

APPLICATION FILED JULY 23, 1903.

918,263.

Patented Apr. 13, 1909.

2 SHEETS—SHEET 1.

FIG. 1

FIG. 2

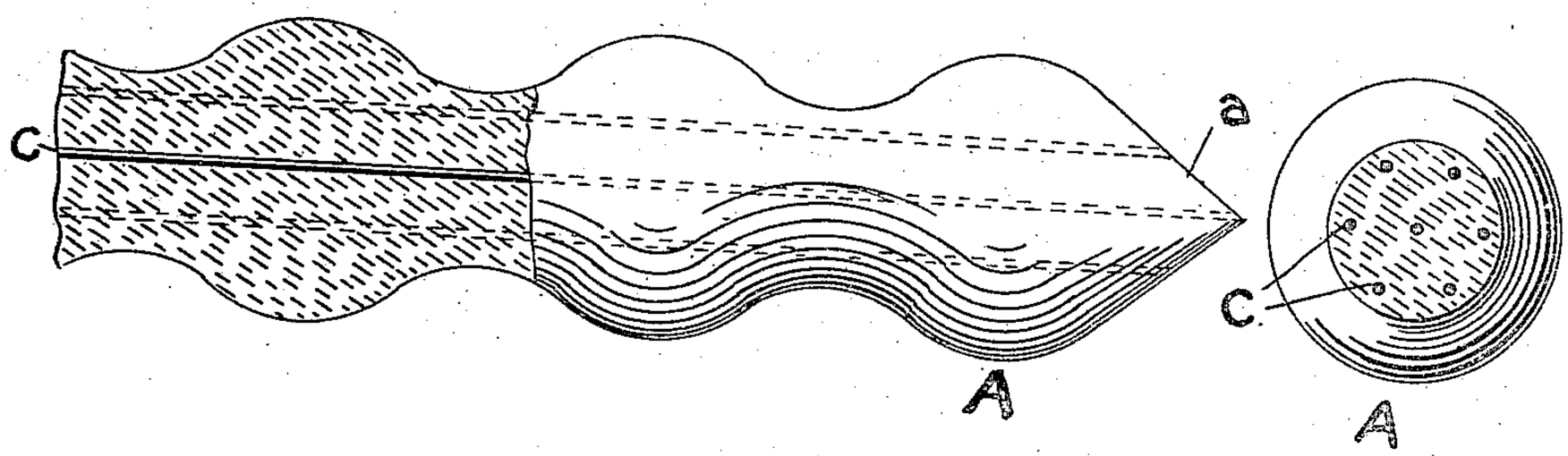


FIG. 3

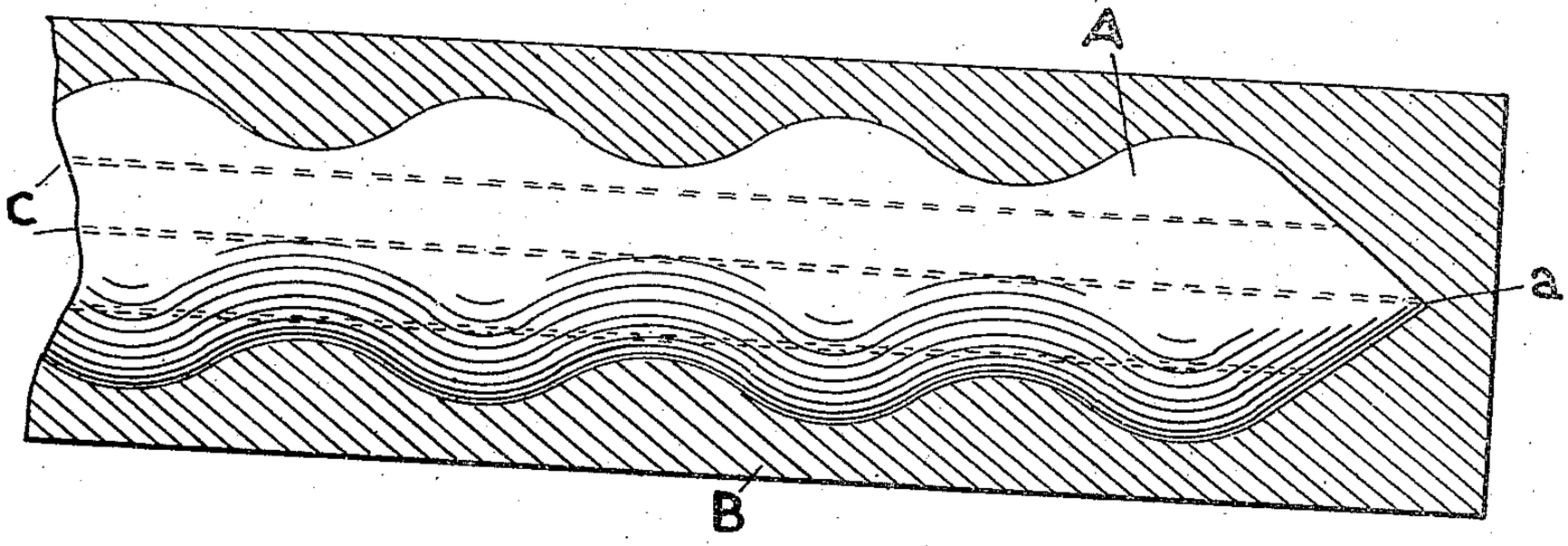
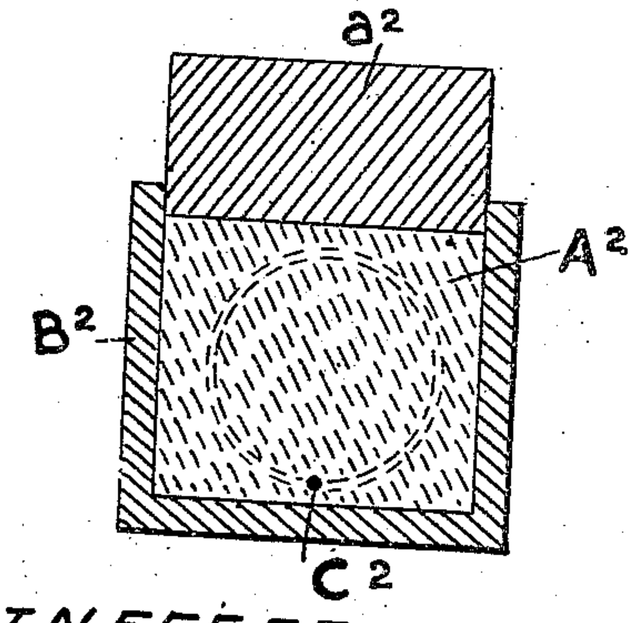
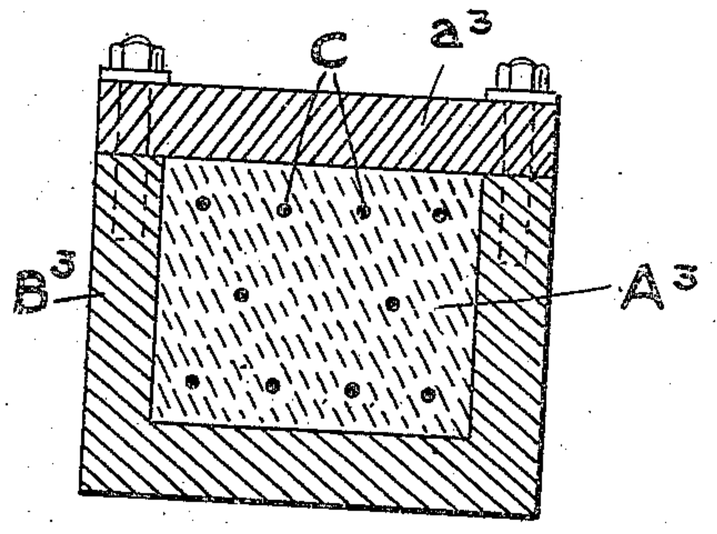


FIG. 4

FIG. 5





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2 SHEETS—SHEET 2.

FIG. 6

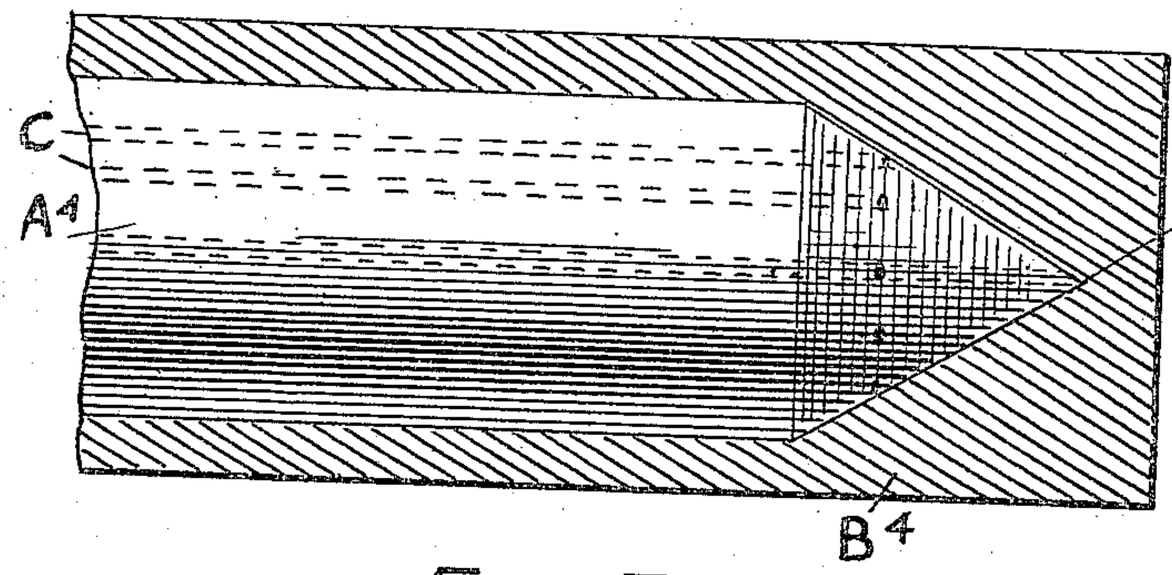


FIG. 7

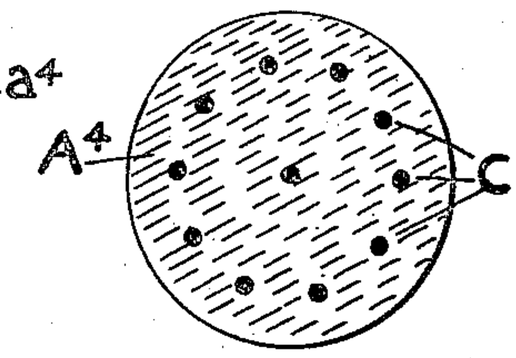


FIG. 8

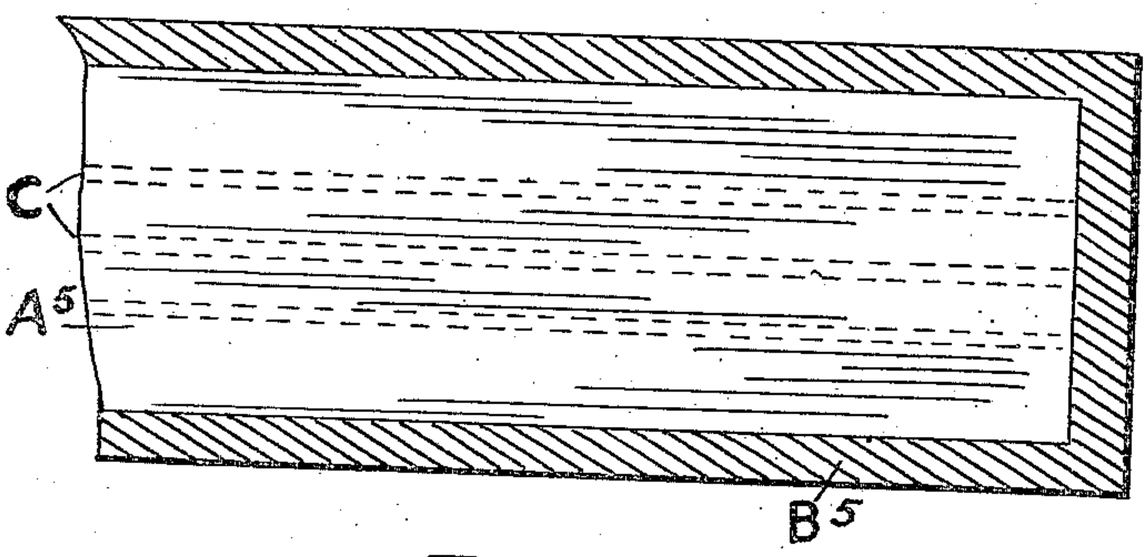


FIG. 9

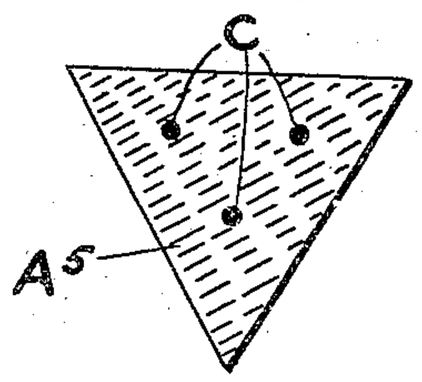


FIG. 10

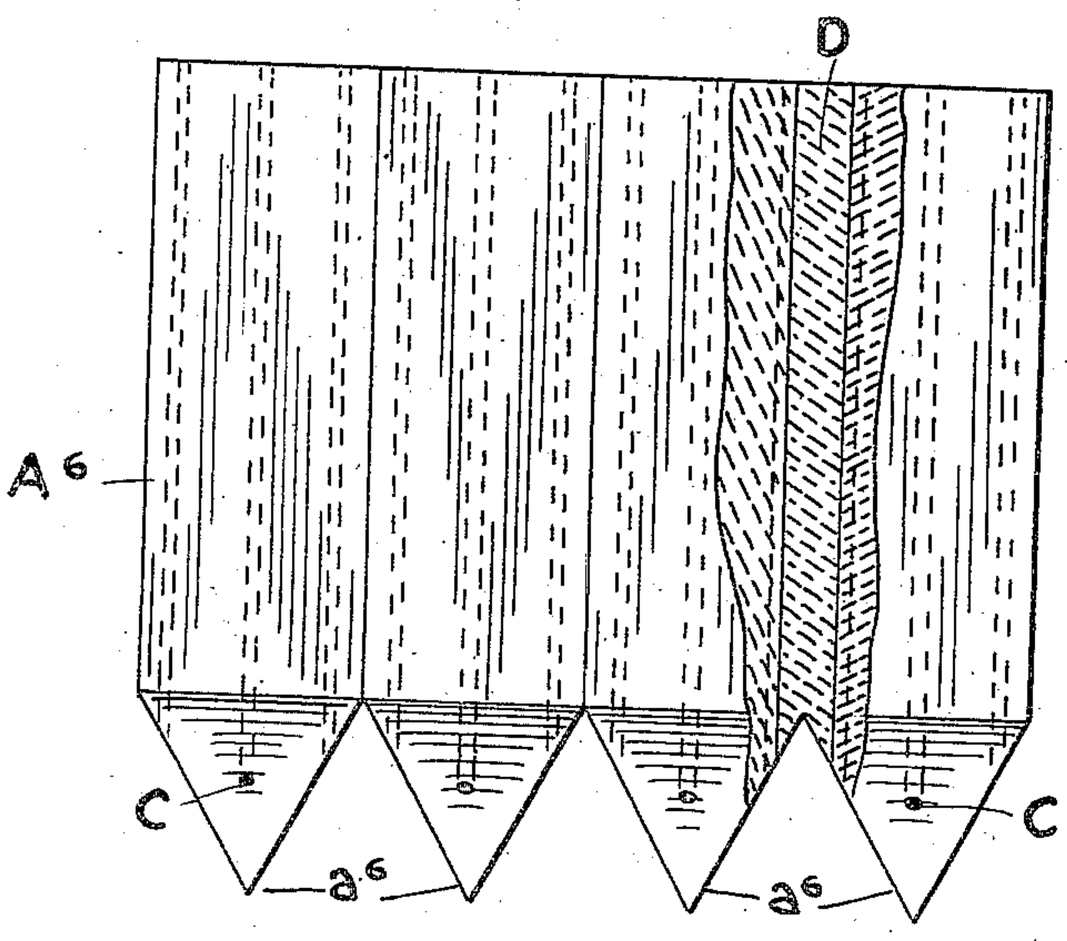
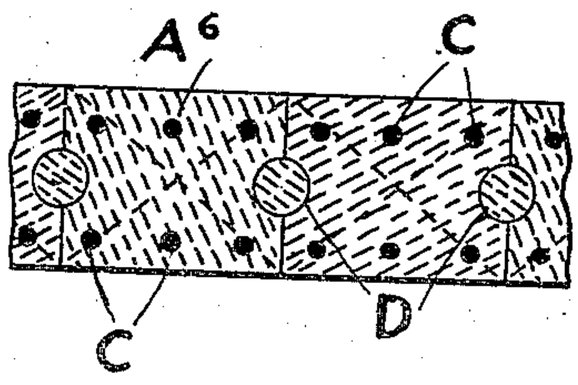


FIG. 11



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UNITED STATES PATENT OFFICE.

GUSTAV A. BEHRND, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR OF ONE-HALF TO THOMAS THOMSON, OF SAN FRANCISCO, CALIFORNIA.

METHOD OF MAKING PILES.

No. 918,263. Specification of Letters Patent. Patented April 13, 1909.

Application filed July 23, 1903. Serial No. 166,765.

To all whom it may concern:

Be it known that I, GUSTAV A. BEHRND, a citizen of the United States, and resident of the city and county of San Francisco, in the State of California, have invented a new and useful Method of Making Piles, of which the following is a specification.

From time immemorial there has been a demand or rather an eager desire on the part of architects, engineers, and builders generally, for a pile that could resist the burrowing of the teredinoid bivalve and withstand the attacks of the elements.

To satisfy this demand or desire is the object of my invention.

The said invention will be explained with reference to the accompanying drawings, which form an inseparable part thereof and in which all similar details are indicated by corresponding letters and exponents throughout the various figures.

Figure 1 is a side view, partly sectioned, of the bottom end of a pile made by my method, the same having a wavy outline or nodulous contour. Fig. 2 is a section across the middle portion of the preceding figure, looking either way. Fig. 3 is a somewhat longer side view of the same type of pile, showing it in the form or mold in which it is made, the latter appearing in longitudinal section. Fig. 4 is a cross section of a square or rectangular pile and the form or mold therefor, both made in accordance with the invention. Fig. 5 is a similar view of an analogous pile and mold or form. Fig. 6 is a side view of the lower end of a cylindrical pile, shown also in its mold or form, which is in section. Fig. 7 is a cross section of this pile, removed from the form or mold. Figs. 8 and 9 are views similar to Figs. 6 and 7, respectively, and illustrate a pile of triangular shape, with part of its mold or form. Figs. 10 and 11 are respectively a side elevation and a sectional plan, representing the invention applied to sheet-piling.

Piles made by my method are formed of hydraulic cement, that is, of cement which will harden under water, which is subjected to a very great pressure, exerted from without the mold in any approved manner, or the pressure may be exerted from within the mold by using an expanding cement such as that known in the art as Teutonia cement, this latter cement having the property of increasing in volume after it is mixed and before it becomes firmly set. Other cements may be employed instead of the Teutonia, if containing, or used with the addition of, a suitable percentage of gypsum, which will cause them to dilate, and which percentage may amount to about one-fifth of the whole.

As hereinabove intimated, and sufficiently indicated in the drawings, the pile may assume a large variety of shapes, all of which may be made by the method contemplated by this invention. However, that represented in Figs. 1, 2 and 3, and lettered A, is believed to be superior in so far as its circumference comprises a number of alternate, annular swellings and hollows, or ridges and dips, or nodes or corrugations whereby it is peculiarly well adapted for implanting, so to say, in soft mud or quicksand or other treacherous ground, which will naturally fill in the depressions between the outspreading portions of the pile and buoy it up, as it were, or sustain it so as to prevent or at least minimize its subsiding after it has been sunk or lowered to the required depth. The other piles, shown in Figs. 4 to 11 and respectively designated by A^2 A^3 A^4 A^5 A^6, can likewise have transverse concavities at suitable intervals throughout their length or part thereof for a like purpose, although, not to burden the drawings with unnecessary illustrations and at the same time to exemplify diverse adaptations of the invention, this feature has been omitted from the views last named. It is understood, of course, that the said feature is not particularly a consequence of circularity, sphericity, or angularity, but may be a characteristic of the pile in any of its shapes, whether it be a derivative of a prism or of a cylinder or other geometrical figure.

In making the pile, the cement is properly hydrated and worked to the consistency of a stiff mortar, which is dropped or shoveled into the form or mold required to impart to it the desired shape. Outwardly each form or mold has a troughlike appearance, but the inner walls thereof must necessarily conform to the shape to be imparted, that is to say, will be either straight or unevenly fashioned to produce corresponding surfaces on the matter which they are made to inclose. Thus, a form B with an inside circular undulating surface is provided for the pile A, as shown in Fig. 3. Other forms B^2 B^3 B^4

B^5, straight-walled inwardly, are supplied for the piles A^2 A^3 A^4 A^5, Figs. 4, 5, 6, 8, and so on for differently-shaped piles; and these forms will vary from one another in cross section according as the pile is to be prismatic or cylindrical. Preferably, all the forms are brought to a point at one end internally, in order to produce a corresponding point or wedge at that end of the pile which is first to enter the ground, such for instance as is shown at a or a^4 or a^6 in Figs. 3, 6, and 10. I provide a metallic bond in the cement as it is being deposited into the form to make a pile,—this to insure greater cohesiveness of the mass and augment the crushing strength of the finished pile. The metal that may be employed varies considerably in grade and shape. I have shown plain, straight rods C in most of the figures of the drawings, which rods may be of iron or steel and disposed at more or less regular intervals in the mass of cement. Several similar rods can advantageously be placed in parallelism longitudinally of the form and pile made therein, and the same may be kept separate as shown, or interconnected in any suitable manner. But they need not be disposed lengthwise, as a transversal or oblique arrangement would answer the purpose with equal advantage. Fig. 4 suggests the use of a single rod C^2 twisted into an advancing spiral, either cylindrical or conical, and centrally embedded in the cement. I also use wire netting and "expanded" metal (so-called), that is, punched and laterally-spread sheet-metal. After the form is thoroughly packed or filled, pressure is applied to its contents in either one of two ways, according to the nature of the cement employed, whether common or expanding. If non-expanding cement is used, then a top piece as a^2, Fig. 4, is placed upon it and forced down into the form by hydraulic power till it (the cement) and the metal combined therewith are united and pressed into a compact, denser body, which constitutes the finished pile when the cement has completely solidified. When expanding cement is selected instead, the top piece in that case is made large enough to cover the entire form, to which it is bolted fast, as the top a^3 to the form A^3, Fig. 5, covering the withinlaid, combined cement and metal. As this cement tends to swell, it is prevented from so doing by the covered form inclosing it, with the result that, being kept confined till it has solidified, the cement operates to press itself and the metal within to the extent of the difference between its bulk when set and what it should be were it allowed to expand as it would under normal conditions. Thus we have a self-pressed hydraulic pile. The tops a^2 a^3, it will be understood, are made to match the sides and ends of their respective forms, whatever their internal configuration may be. The pressure of the mass of cement and metal renders it more uniform or less porous and is accompanied with a corresponding increase in its power of resistance to crushing after it is set and has become a finished pile. This resisting power equals tons to the square inch and is many times that of an unpressed body of same material and dimensions. The pile in fact is a great deal more solid than a rock of same proportions, and indestructible and imperishable as well. It is quite evident, without comparing this invention with any other or referring to anything else but old and well-known constructions, that no teredo will bore into such a pile as it does with the common wooden piles, nor will the pile split, crumble away or gradually fall to pieces as the creosoted article, nor is it subject to rust or crystallization like the metallic pile. Briefly, it is not liable to decay from any cause; it will not be injuriously affected by extremes of heat or cold or by variations in meteorological conditions or by alternate exposure to drought and humidity; it is impermeable to water and will not rot if the surrounding ground should dry up at the surface; it is invulnerable to all vegetable or animal fungi or parasites; it is proof against fire and storms and practically also against seismic disturbances; it will bear enormous weights, offer indefinite resistance to concussion, withstand the heaviest impact, etc.

Figs. 10 and 11 illustrate how this invention is adapted to forming continuous walls or revetments, as in sheet-piling or for other purposes. As shown in these two views, the pile A^6 can be grooved longitudinally on each side so that when a number of piles are placed in juxtaposition the grooves in adjoining piles will register and form together a cylindrical opening or bore which can be filled with the same material with which the piles are made. This material, hydraulic cement, can be rammed in to tightly fill the said grooves as represented at D in the two said figures, and then it is allowed to set, after which the piles will be so well united as to form one solid mass, having obvious advantages.

It would be superfluous here to particularize all the uses to which the above described invention can be put or all the ways in which it can be employed. It will be sufficient to point out that this improved pile the product of this method of making is available as a foundation-pile or for any kind of substructure or underground support; for coffer-dams and caissons; for piers, trestle-work, or quay-walling; for ferry-slips, breakwaters, or shore defenses; for dikes, jetties, harbor-dams, seawalls, etc., etc.

Having described my invention, what I claim, and desire to secure by Letters Patent of the United States, is:—

1. A process of making piles which comprises filling a suitable form with fresh mixed calcareous cement, subjecting the packed cement therein to a high pressure, and causing the pressed cement to set wholly within the form.

2. Packing fresh mixed calcareous cement and a binding metal in a suitable form, pressing the mass as a whole and leaving it to set.

3. Filling a suitable form with fresh mixed calcareous cement, pressing the mass laterally therein and letting it solidify while under pressure.

4. Filling a suitable form with fresh mixed expanding calcareous cement, completely closing the filled form to oppose dilatation of the mass therein, and leaving the mass to set while in restraint.

5. Filling a suitable form with fresh mixed expanding calcareous cement and a binding metal, completely closing the form so as to prevent expansion of the mass therein, and leaving the mass to solidify in the closed form.

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