

Oct. 16, 1928.

1,688,064

M. M. UPSON

CONCRETE PILE

Filed Jan. 29, 1925

3 Sheets-Sheet 1

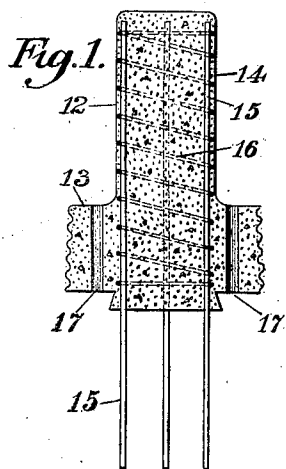
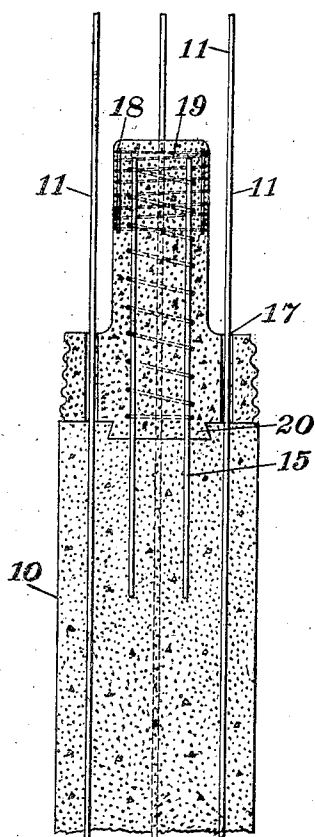


Fig. 2.

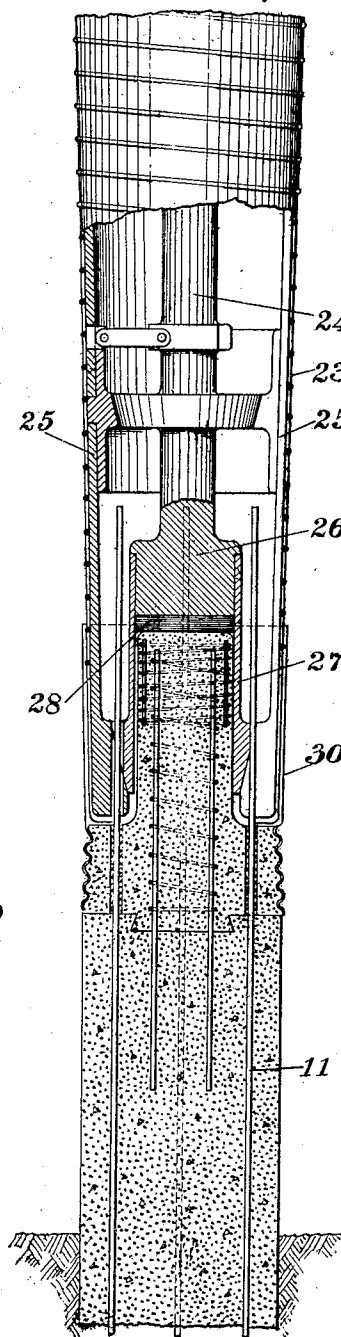


Fig. 3.

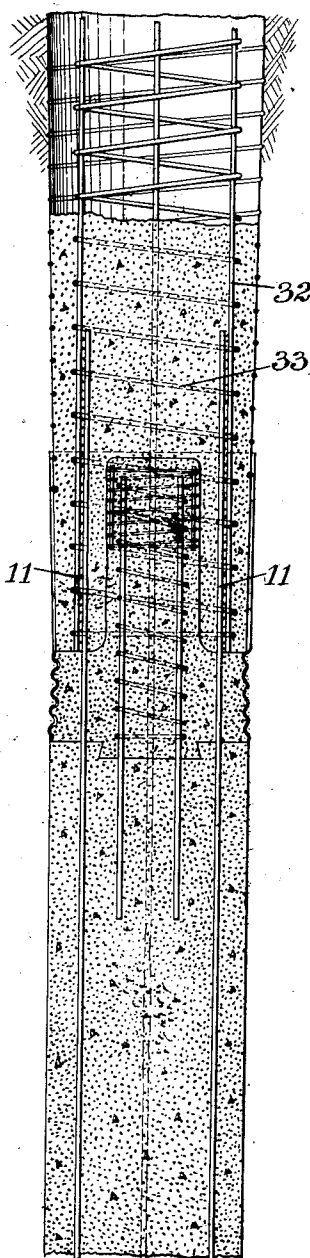


Fig. 4.

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3 Sheets-Sheet 2

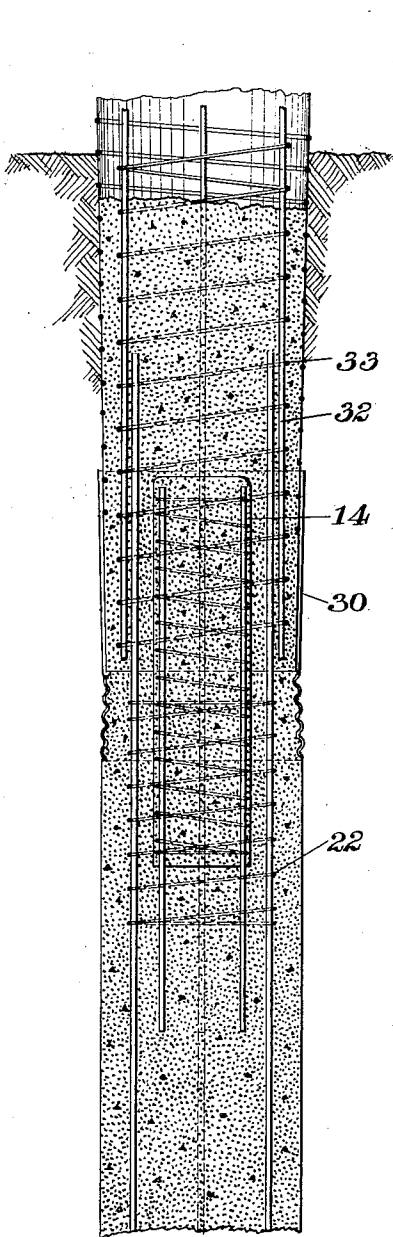


Fig. 5.

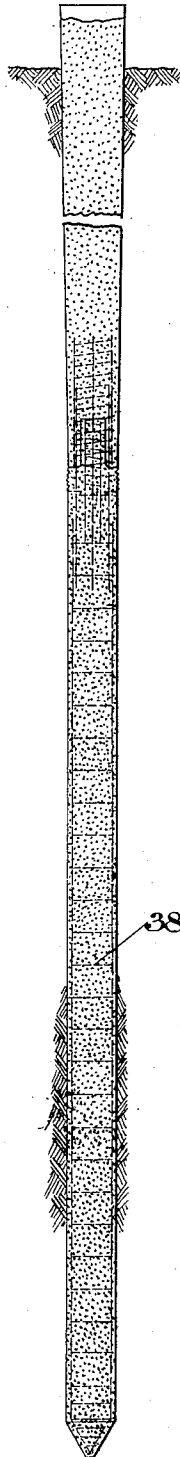


Fig. 7.

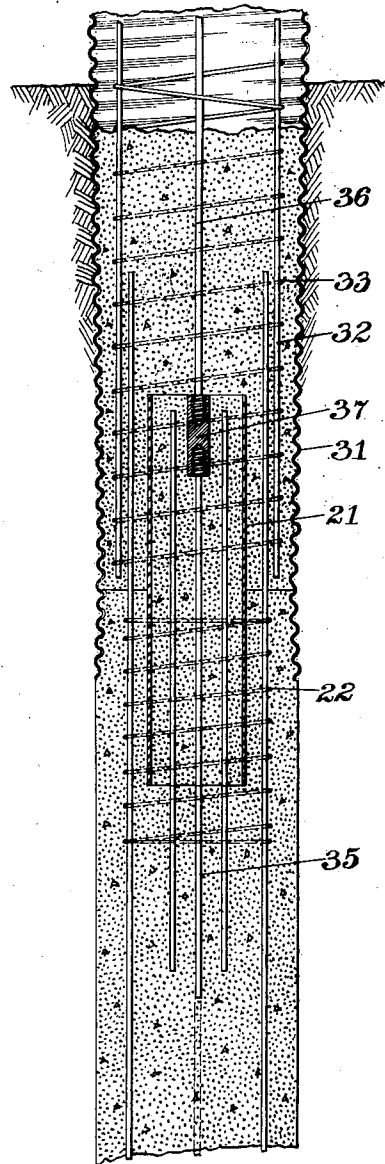


Fig. 6.

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3 Sheets-Sheet 3

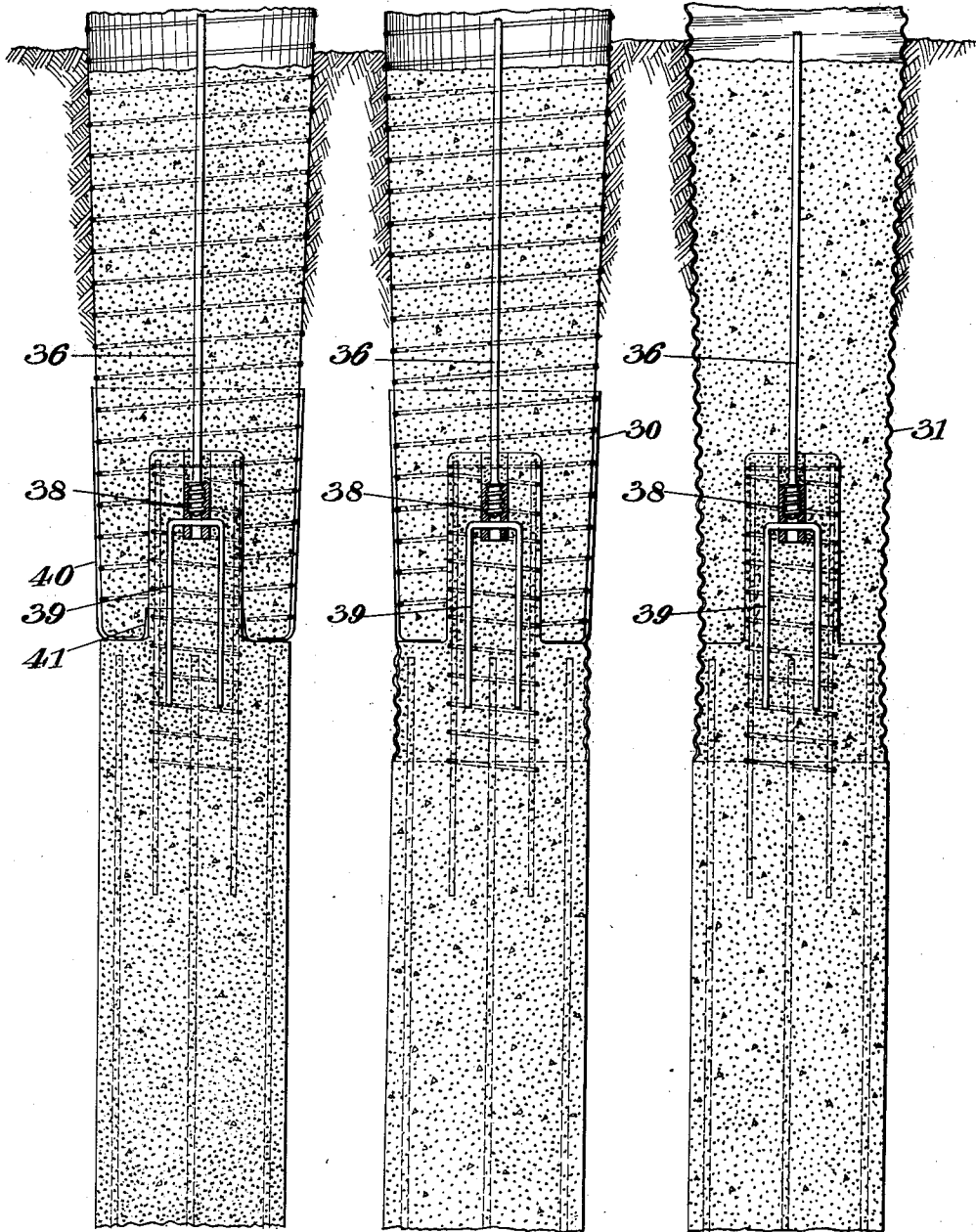


Fig. 8.

Fig. 9.

Fig. 10.

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CONCRETE PILE.

Application filed January 29, 1925. Serial No. 5,436.

The use of precast concrete piles has heretofore been seriously limited by certain disadvantages which have been, in most cases at least, sufficient to more than offset the advantages of such piles, with the result that the field has been held almost entirely by piles cast in place. Among the disadvantages alluded to, one of the most unfavorable has to do with the steel reinforcement. These piles, being composed of concrete, have inherently very little resistance to bending stresses such as they necessarily are subjected to in handling, and hence it is necessary to provide them with reinforcing members much heavier than is ever required for the service which they are intended to render as supporting piers. Moreover, the amount or weight of reinforcement needed for safe handling as the pile is lengthened increases in greater than arithmetical proportion. Also, it is seldom if ever possible to determine with accuracy the length of pile that can or should be driven in a given job. For that reason a precast pile may prove too long, thereby resulting in waste, or it may prove too short, thereby entailing the delay and expense of splicing. Again, precast piles must have considerable time to set and "cure" before they can be driven, thus causing loss of time between casting and driving.

My present invention is designed to avoid as far as possible such difficulties as the above, at the same time preserving certain advantages of the precast construction. To this and other ends the invention comprises the novel features and combinations hereinafter described.

In carrying out the invention in the preferred manner the lower portion of the complete pile is precast and the upper (usually the shorter) portion is cast in place, though it is to be understood that in many cases the precast section can be used alone. In order to save time between casting and driving I provide the precast pile with a driving head composed of concrete in which the cement is of a quick-setting variety, thereby making the head of the pile sufficiently hard and firm to permit driving within a few days (instead of weeks, as heretofore) after casting, and in addition I may treat the body of the pile to hasten setting, as by adding calcium chloride to the mix, say to the amount of 4 parts, by weight, to 95 or 100 parts of the water used. The driving head or cap may be cast integral with the body of the pile by

using the quick setting concrete in the upper part of the mold, or it may be precast in a separate mold of accurate dimensions and shape; or I may cast a wooden block in the end of the pile to take the impact of the blows in driving.

After the precast pile is sunk to the desired depth a pile-shell and driving core are assembled on top of it and the driving is continued until the proper bearing is reached. The core is then withdrawn and the shell filled with concrete. In assembling the shell on the precast pile or section the driving head of the latter is encased in a boot or sleeve into which the shell fits snugly, to exclude mud and water, or the shell itself may be secured to the upper end for the same purpose. In either case I prefer to thread the boot or otherwise fasten it or the shell onto the pile so as to afford firm resistance to separation of the pile and the shell or boot due to heaving of the ground before the concrete in the shell has set.

The use of precast and cast-in-place sections makes it possible to use precast units of comparatively short length, thereby reducing to a minimum the amount of reinforcing steel needed and effecting a marked saving in cost. Moreover, the length of the precast unit is always less than that of the completed pile, so that the annoyance and cost of splicing is never encountered; while the time between casting and driving is reduced (in many cases to a practically negligible period) by the special driving head which will stand the abuse of driving shortly after the unit is cast.

Referring now to the accompanying drawings, in which several forms of the invention are illustrated:

Fig. 1 is a longitudinal section of a precast concrete driving head for the precast pile.

Fig. 2 is a longitudinal section of the upper end of a precast pile or pile-section, with a concrete driving head.

Fig. 3 is a longitudinal section showing a precast unit and a shell and collapsible driving core assembled thereon.

Fig. 4 is a longitudinal section of the joint between the precast and cast-in-place sections, the shell in which the latter is cast being only partly filled with concrete.

Fig. 5 is a view similar to Fig. 4 but showing a driving head cast or formed integral with the precast section.

Fig. 6 is a similar view showing another type of driving head.

Fig. 7 is a longitudinal sectional view of a pile composed of a precast unit and a cast-in-place section.

Figs. 8, 9 and 10 are longitudinal sections illustrating various composite pile constructions employing as a locking means a modification of the means shown in Fig. 6.

The precast pile is represented at 10, and is shown provided with reinforcing members 11, of any suitable kind and arrangement, the amount of steel used being preferably no more than sufficient, with a fair margin of safety, to give the strength needed for handling. These longitudinal reinforcing members extend well beyond the upper end of the pile. The driving head 12, Fig. 1, is precast, using quick-setting concrete, in a mold of accurate size and form, and may be made in quantities at a convenient place for shipment to the point of use. The head shown consists of a base 13, of the same diameter as the upper end of the pile 10, and a longitudinal extension or tenon 14, the whole being suitably reinforced, as by means of longitudinal rods 15 and circumferential wire or wires 16, which may be wrapped helically around the rods. The base 13 may also be provided with holes or passages 17 to receive reinforcing bars, as 11, projecting from the precast pile 10, as shown in Fig. 2. The head-reinforcing rods 15 are extended well below the base 13, and the upper end of the tenon 14 may have additional reinforcement, as the short rods 18 and spiral wrapping 19, Figs. 2, 3 and 4, to afford greater resistance to the abuse of driving, especially when it is known that severe driving conditions will be encountered. The precast head and the precast pile can be secured together in any convenient way, but I prefer to unite them by casting the pile in contact with the head, or forcing the head upon the unset concrete of the pile. In either case the lower extensions of the head-reinforcing bars 15 are anchored firmly in the body of the pile, and for additional strength I may provide the head with a downward extension, preferably of dovetail form as indicated at 20, to bond into the pile. After the head is set in position the holes 17 may be grouted, as indicated in Fig. 3. As previously stated, the pile itself, as distinguished from the driving head, can be made quick-setting by adding calcium chloride to the water. Using 4 per cent of calcium chloride the time of setting and curing can, under favorable conditions, be reduced 50 per cent or even more. Steaming may also be resorted to, though the expense of such treatment is prohibitive in most cases except for the head.

Instead of precasting the head, the pile and the head may be cast together, using the same mixture for both, or in the part constituting the head any well known quick-setting cement

may be used. Or the tenon may be cast separately, in the form of a reinforced cylinder, and then positioned in the mold in which the shaft of the pile is cast, after which the mold is filled with concrete. This gives a precast section such as is shown in Fig. 5, for example.

In either method, the tenon may be formed of a short length of steel pipe, as 21, Fig. 6, and where driving conditions are severe the head and upper end of the shaft of the pile can be additionally strengthened by spiral reinforcement, as indicated at 33, Figs. 5 and 6.

After the precast pile has been driven as far as necessary a pile-shell, as 23, Fig. 3, and a suitable driving core, are assembled on top, as in the figure just mentioned, the core being preferably of the collapsible type indicated, with a specially designed lower end to fit over the tenon on the driving head, or of the non-collapsible type described in my prior Patent No. 1,491,832, April 29, 1924. As shown in Fig. 3 the lower end of the center rod 24, by which the leaves or plates 25 are expanded and contracted, is provided with an enlarged lower end 26 having a tubular casing or extension 27 which embraces the tenon, and the plates extend down around the tenon toward the base of the head. To ease the driving impact on the concrete and decrease the tendency to chipping it is desirable to provide a cushion, as 28, which may be made of laminated wood, old rope, or other convenient material, between the tenon and the enlargement 26.

It is highly desirable to exclude water from the shell, so that the joint between the precast and cast-in-place sections will be as strong as possible, and for this purpose I provide the driving head with a boot of sheet metal, 30, into which the shell 23 fits snugly, as indicated in Fig. 3, the boot being preferably formed with screw-threaded grooves to screw on screw-thread corrugations formed on the driving head, for better resistance to the upward pull incident to heaving of the ground. A better plan is to provide the entire shell, or at least the lower portion thereof, with screw-thread corrugations, as in my prior Patent No. 1,491,832, mentioned above. In such case the special boot can be dispensed with, even where it would otherwise be needed, and the shell itself screwed down on the precast pile. A further advantage of a corrugated shell is that the shell-sections, where a single section is not long enough, can be joined by screwing one into the other, as fully described in my patent just referred to. A shell so made up offers maximum resistance to tensile stresses, which in some soils are powerful enough to pull the cast-in-place section apart. A corrugated shell for the cast-in-place section is shown at 31, in Fig. 6. If a corrugated shell is used the core should

also be corrugated, as in the aforesaid patent.

The shell and core having been assembled as described the driving is resumed, and is continued until the whole assembly is sunk to the desired depth, after which the core is withdrawn and the shell filled with concrete to form the cast-in-place section. In some cases I prefer to reinforce the latter section around the tenon on the precast section, as by the vertical rods 32 and spiral wire or wires 33, Figs. 4, 5 and 6, if this is found necessary in order to make the joint, which is the most important part of the structure, at least as strong as the rest of the precast unit. In many cases the rods 11, projecting into the cast-in-place section from the precast section, will be found sufficient to give the degree of strength indicated, especially if provided with spiral reinforcement. Where excessive lateral stresses are encountered the reinforcing members of the cast-in-place section can be extended well up above the joint, and even clear to the top of the section.

To provide additional security against separation of the two sections they may be locked together by other means, for example as shown in Fig. 6, comprising anchor rods 35, 36, embedded in the pile sections and screwed or otherwise connected to an anchor block 37 which may be embedded in the tenon of the driving head on the precast section.

Fig. 7, which illustrates a complete pile embodying certain important features of the present invention, shows also the use of stirrup or circumferential reinforcement, as 38, around the longitudinal rods in the precast section, to insure adequate strength when the section is of extra length.

In the construction illustrated in Figs. 8, 9 and 10 the two sections of the complete pile are locked together by means similar to that indicated in Fig. 6. In the three figures first mentioned the socket 38, into which the rod 36 is screwed before the upper pile-section is cast, is held securely in the tenon by an anchor 39 of inverted U-shape. The boot 30 at the bottom of the cast-in-place section in Fig. 9 is the same as in Fig. 4, and in Fig. 10 the corrugated shell 31 is screwed down on the precast section as in Fig. 6. In Fig. 8 the boot 40, encasing the lower end of the cast-in-place section, has an opening in its bottom to receive the tenon of the precast section, and this open-

ing is surrounded by a collar 41 which may have an inward taper so that it will grip the tenon and aid in resisting longitudinal stresses tending to separate the two sections. In many cases the construction shown in Fig. 8 has ample strength to stand the stresses encountered in practice.

It will be observed that in all the forms illustrated the tenon of the precast section is embedded in the cast-in-place section, the concrete of the latter being cast around the tenon. Moreover, the tenon and the surrounding concrete of the cast-in-place section are reinforced against longitudinal and transverse stresses so as to make the joint preferably as strong as any other part of the pile. The amount of steel indicated in Figs. 1 to 7 of the drawings is adequate for the purpose in practically all cases, and in many instances less will be found sufficient, as in Figs. 8, 9 and 10, for example, especially if the longitudinal members are twisted or otherwise shaped to give a good grip on the concrete.

It is to be understood that the invention is not limited to the specific details herein illustrated and described but can be embodied in other forms without departure from its spirit.

I claim—

1. The method of making a concrete pile which comprises precasting a lower section of the pile with a driving head portion, driving the said lower section after the driving head portion has attained safe driving strength and while the portion thereof below the driving head is comparatively green, and casting a pile section in place on the driving head portion of the precast section.

2. The method of making a concrete pile which comprises precasting a bottom section of the pile, permanently securing to the upper end of the bottom section a driving head portion capable of receiving and substantially uniformly transmitting driving impacts to the bottom section without damage to the latter while it is comparatively green, driving the bottom section by blows delivered to the driving head, and supplying any deficiency in length of the pile by casting a pile section in place upon the driving head.

In testimony whereof I hereto affix my signature.

MAXWELL M. UPSON.