

Dec. 10, 1946.

C. WEBER

2,412,239

METHOD OF PRODUCING PILING

Filed March 15, 1945

2 Sheets-Sheet 1

Fig. 1.

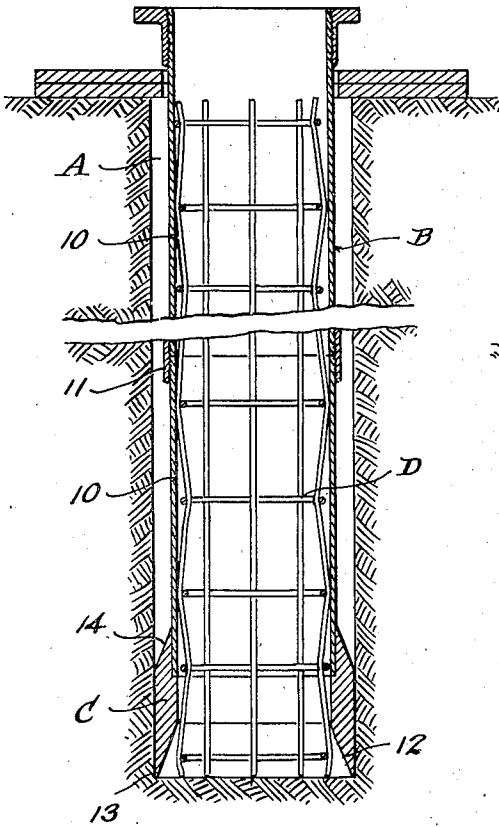


Fig. 2.

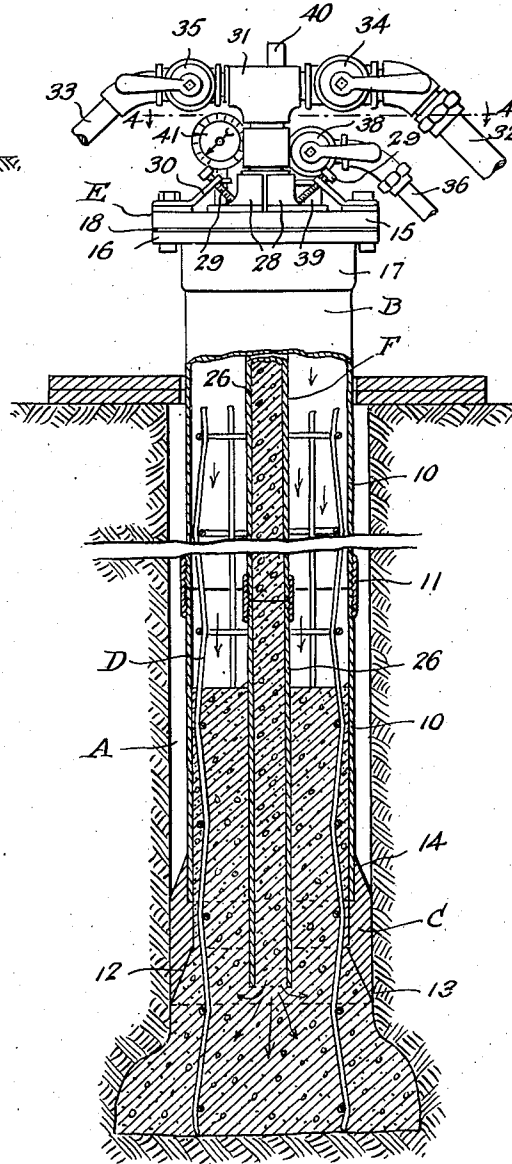
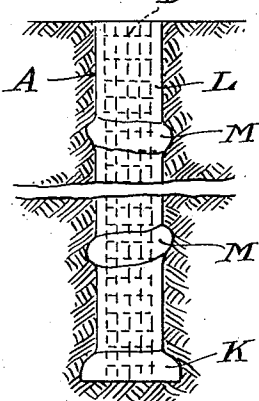


Fig. 3.



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Fig. 4.

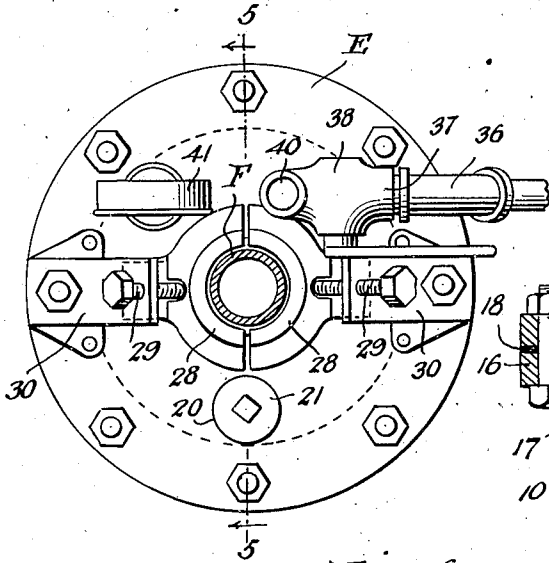


Fig. 5.

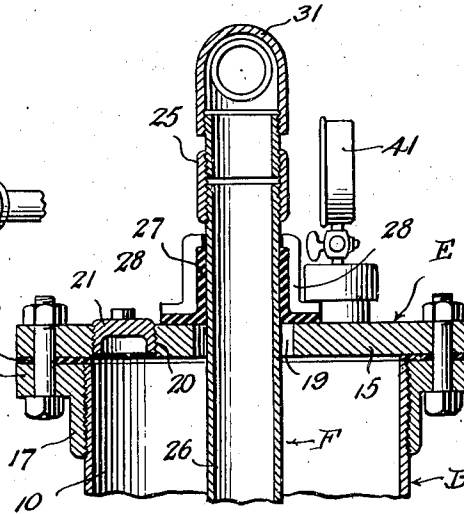


Fig. 6.

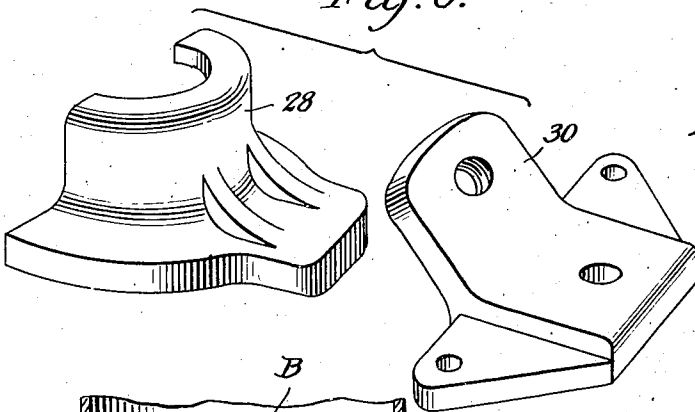


Fig. 7.

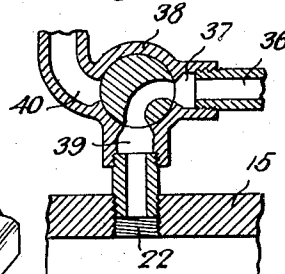
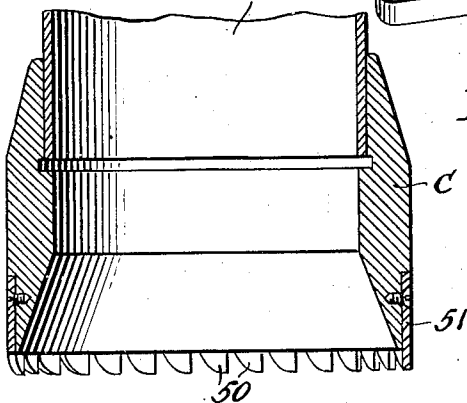


Fig. 8.



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UNITED STATES PATENT OFFICE

2,412,239

METHOD OF PRODUCING PILING

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10 Claims. (Cl. 61—57)

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This invention comprehends a method of producing piling employed for various purposes such as for the support of buildings, bridges, piers and the like, the invention being particularly directed to what may be termed built-in-place piles of concrete or any equivalent composition.

The invention primarily aims to facilitate the production of piles of this character of improved quality, at lower cost than heretofore and to provide the same with reinforced steel bars, rails or structural shapes of any form in order to resist bending and tensional stresses wherever necessary, the method employed offering numerous other technical and commercial advantages, namely, that the piles may be built without the use of cumbersome pile driving equipment with the result that the jarring, shaking and other ground disturbing influences caused by the customary pile ramming operations as well as the noise incident thereto, are entirely eliminated. The method further admits of the production of piles in very restricted working places, such as inside of existing buildings and under many conditions where the installation of other types of piling is impossible, while permitting their production at any desired degree of inclination from the vertical to the horizontal position and practically without limit as to form, size or depth of the piling below ground or to their extension above ground or water levels.

The present method accomplishes the foregoing and other results by the injection of concrete, under compressed air or other gaseous fluid pressure, into protected pile wells which are produced as needed and maintained in the ground under constant gaseous fluid pressure until the concrete is emplaced therein so that deformation of the pile receiving and forming well is rendered impossible by settling, shifting or collapse of the ground surrounding or in the immediate region of the well.

With the above recited and other objectives in view, the invention is set forth in greater detail in the following specification, particularly pointed out in the appended claims and illustrated in the accompanying drawings, in which:

Fig. 1 is a vertical sectional view through a pile forming well immediately after the reception pipe and reinforcing means have been emplaced.

Fig. 2 is a similar view illustrating the method of emplacing the concrete and forming the pile as the pipe assemblage is being raised.

Fig. 3 is a view on a reduced scale illustrating

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a completed built-in-place pile located in the ground well.

Fig. 4 is an enlarged sectional plan view taken approximately on the line 4—4 of Fig. 2.

Fig. 5 is a fragmentary sectional view taken on the line 5—5 of Fig. 4.

Fig. 6 is a collective perspective view of one of the mating clamping sections for the gasket and the angulated lug in juxtaposition thereto.

Fig. 7 is a fragmentary sectional view showing the three-way valve mounted on the pressure head.

Fig. 8 is a fragmentary sectional view of a modification of the form of cutting shoe which may be employed with the method.

The method of producing the built-in-place piling is carried out in the following manner and consists in initially forming in the ground such as the bed of a river or any other place a well A which eventually functions as a form within which concrete or an equivalent plastic composition is moulded to provide the built-in-place pile. In practice, it is essential to employ suitable means for restraining or holding back the wall of the well while the concrete is being emplaced in addition to providing means for conveying the concrete to the bottom of the well and depositing the same progressively upward from the bottom to the top of the same until the well is completely filled. Such means is herein illustrated as a tubular reception pipe B which is of the required diameter and preferably, as shown, made up of comparatively short sections or lengths 10 joined together by coupling sleeves 11 which are added to the upper end as the sinking of the well A progresses.

In view of the fact that the reception pipe B is only temporarily emplaced in the well A and is subsequently withdrawn therefrom for reuse, that in order to minimize the surface friction both during the sinking of the well and the ultimate withdrawal of the pipe B, the same is preferably somewhat smaller in diameter than the cross-sectional size of the well A. In addition to its other functions, the pipe B may also be employed as means for facilitating the excavation and removal of the excavated material by any of the well known methods, such as by hydraulic jetting or other well digging equipment, not shown.

A cutting shoe C is secured to the lower end of the lower section 10 of the reception pipe B, said shoe having the inner periphery corresponding in size and shape to the inner periphery of said pipe while the outer periphery may be of

any desired shape and an appreciably greater size than the outer periphery of the reception pipe. The lower end portion of the shoe has a downwardly and outwardly flaring inner periphery 12 terminating in a sharp lower cutting edge 13 to facilitate the forcing of the shoe and reception pipe downwardly during the sinking of the well A. The upper portion of the shoe is formed with an upwardly tapered outer periphery 14 to facilitate the subsequent upward movement of the same during the withdrawal of the pipe from the well and said tapered portion 14 also functions to restore said well to its original profile or cross-section wherever the same may have temporarily assumed a distorted form due to caving of the earthen walls or deformation due to ground pressure.

After the well A has been sunk to the desired depth with the reception pipe B in place, as shown in Fig. 1, reinforcing means D are emplaced in the well within the confines of the reception pipe to later serve as means for resisting bending or tensional stresses, it being understood that said reinforcing means are so located as to provide a free passageway extending longitudinally of and within the reception pipe.

A pressure head assembly E is then secured to the uppermost end of the reception pipe to close and seal the same and said assembly E consists of a base plate 15 which is bolted to the outwardly projecting marginal flange 16 of a collar 17 threadedly engaged over the upper end of the uppermost section 10 of the reception pipe B with a suitable sealing gasket 18 interposed between the flange and plate. The base plate is formed with a central opening 19, a control opening 20 normally closed by a closure plug 21 and with a pressure inlet port 22. A conduit pipe F is inserted through the central opening 19 which is large enough to also permit of the passage therethrough of coupling sleeves 25 which connect together the sections 26 making up the conduit pipe F, the lower end of which is extended downwardly through the reception pipe until it is located within the shoe adjacent to the cutting edge 13. After the conduit pipe F has thus been emplaced, a gasket 27 is arranged in covering relation to the central opening 19 and in surrounding relation to the adjacent protruding portion of the conduit pipe and said gasket is clamped in place to seal the pipe within the central opening by means of mating clamping sections 28 which are urged downwardly and into surrounding relation with the gasket 27 by screws 29 threaded through angulated lugs 30 anchored to the upper surface of the base plate 15. A T-shaped fitting 31 is then secured to the upper end of the protruding portion of the uppermost section 26 of the conduit pipe F and a concrete injector pipe 32 is attached to one branch of said T-shaped fitting, while an outlet pipe 33 is attached to the remaining branch of said fitting, shut off valves 34 and 35 being located in the concrete injector and outlet pipes respectively, to open and close the same.

A pressure pipe 36, connected to a source of compressed air, steam or any other equivalent gaseous fluid under pressure, is attached to the inlet port 37 of a three-way valve 38, another port 39 of which extends downwardly and communicates with the interior of the reception pipe B through the inlet port 22 in the base plate 15, while the remaining exhaust port 40 of said three-way valve 38 extends upwardly and opens to the atmosphere. A pressure gauge 41 is mounted on

the base 15 and communicates with the interior of the reception pipe B to indicate to the operator the pressure therein.

In carrying the method forward, after the pressure head assembly E has been attached and the conduit pipe F has been emplaced, any ground water within the well may be forced from the well A by opening the outlet valve 35 in the outlet pipe 33 and then turning the three-way valve 38 so that the working pressure is admitted to the reception pipe B thereby causing the water to be forced upwardly through the conduit pipe E and thence through the outlet pipe 33. When all of the ground water has been completely discharged from the well, the outlet valve 35 is closed and the pressure will then function to prevent any water from seeping into the well.

The entire pipe assemblage and pressure head E is then raised so that the shoe C is above the bottom of the well, the valve 34 opened to admit concrete to the conduit pipe F through which it is injected into the bottom of the dried well under pressure and rises within the reception pipe B. When the concrete reaches a sufficient height in the said reception pipe so that it completely seals the bottom of the well, the working pressure is increased above normal to force the concrete laterally or radially outwardly to form a bulb-like footing or enlargement K at the base of the pile L. The pressure is now reduced to the required normal injection pressure and the injection of the concrete continues in stages, until the pile L is completed, the reception pipe and conduit pipe sections being periodically disconnected and salvaged as the work progresses. It is apparent that due to the smaller cross-sectional size of the pipe B with reference to that of the well A, the frictional resistance therebetween is materially reduced so that the working pressure within the reception pipe functions to aid the lifting force employed for raising the pipe assemblage. As previously stated, the form of the cutting shoe C functions to restore the pile well A to its original cross-section wherever the well may have temporarily assumed a distorted form as a result of caving in of the earthen walls or deformation from any other reason.

The working pressure impinged on top of the concrete within the reception pipe B forces said concrete into the well below the cutting shoe C simultaneously with the raising of the same, the concrete filling the well completely under the full working pressure so that it is forced hard against the earthen wall and impacted thereagainst. In soft or pliable ground strata, etc., the injection pressure may so exceed the ground resistance that the cross-sectional size of the pile is increased or expanded. To some extent this proves of advantage by forming bulb-like protrusions M on the periphery of the pile L which affords resistance against settling or rising from upward tension. Where known strata of substantially reduced resistance are encountered, which will be known in advance by the operator who is furnished with a chart prepared from samples as the well A is sunk, the working pressure may be reduced to avoid undue spreading of the pile and the waste of concrete.

The withdrawal of the pipe assembly is accomplished by the uplifting power of the working pressure within the reception pipe B, which obviously exerts the same force in both the upward and downward directions, the speed of withdrawal being regulated by adjustment of the working pressure and by ballasting or jacking of the re-

ception pipe, as needed. As heretofore indicated, the pressure injection of the concrete into the well is performed in stages or periodic lifts, it being understood that whenever the concrete filling within the well has reached a sufficient height to expose one or more of the sections of the reception pipe B, the injection conduit pipe is closed off from the concrete supply pipe 32 by closing the valve 34. The working pressure valve 38 is then adjusted to cut off the working pressure and to permit of the exhaust of the working pressure from the interior of the reception pipe B and after detaching the pressure head assembly E, the uppermost sections the pipes B and F, which extend above the ground, are removed, the pressure head assembly replaced on the remaining uppermost section and the work continued as before explained.

As the building of the pile L approaches its final stages, the plug 21 of the control opening 20 is removed, after venting the working pressure, so as to ascertain the level of the concrete and to discontinue the injection at the exact height so that later costly adjustments are obviated, such as the trimming down or upbuilding of the pile to the specified level.

When the concreting work of the pile has been completed, the entire construction equipment is withdrawn and is available for further use in forming other piles, thereby representing a great saving of cost as compared with other methods which provide metal forms or casing which remain in the ground. It will thus be apparent that the present method dispenses with the use of the customary cumbersome and heavy pile driving rams, avoids the shocks, jars and noise incident thereto and the disturbing of the surrounding ground strata, which is of especial importance where additional supports are being provided for sinking or ruptured structures where such vibrations or disturbances must be avoided. There is no limit to the length, the cross-sectional form and dimensions or to the type and amount of reinforcement that may be desired for the construction of the piling produced under this method, so that it is possible to provide one single large pile instead of a large cluster of common piling often required for the support of heavy structural units.

In the modified form of cutting shoe C, shown in Fig. 8 of the drawings, the same is intended for use only in the production of cylindrical piles which permit of the rotation of the shoe C during the sinking of the well. In this instance, the cutting edge of the shoe is provided with teeth or serrations 50 which may be formed directly on the shoe or on one or more plates 51 secured to the shoe or provided in any equivalent manner.

What is claimed is:

1. A method of producing built-in-place concrete piling which consists in forcing the enlarged lower end of a reception pipe into the ground to the desired depth to form a well of greater cross-sectional size than that of the major diameter of said reception pipe, closing the upper end of the reception pipe and sealing in extending relation through said closed upper end a concrete injection conduit having its lower end disposed adjacent the enlarged lower end of the reception pipe, introducing a gaseous fluid under pressure within the upper end of the reception pipe exteriorly of the conduit and after discharging the ground water in the well upwardly through the conduit by said gaseous fluid pressure, simultaneously raising the pipe and conduit in successive stages

while at the same time displacing the concrete from the pipe and conduit under the gaseous fluid pressure to forcibly impact the concrete in the well to fill the same and produce the built-in-place piling.

2. In a method as set forth in claim 1, wherein after the reception pipe is initially raised from its lowermost position, the pressure of the gaseous fluid is temporarily increased to form a radial enlargement at the lower end of the well to provide a bulb-like footing at the base of the piling when filled with concrete.

3. A method of producing built-in-place concrete piles consisting in initially forcing into the ground a tubular reception pipe having at its lower end a cutting shoe the outer periphery of which is of greater size than the outer periphery of the reception pipe and excavating and removing therethrough the material encompassed thereby to form a well of somewhat greater cross-sectional size than the reception pipe, closing the upper end of the reception pipe to render the same fluid tight, extending through said closed upper end in sealed relation thereto a conduit pipe having the lower end thereof disposed adjacent to the cutting shoe, introducing a gaseous fluid under pressure into the upper end of the reception pipe exteriorly of the conduit pipe, then injecting concrete through the conduit pipe while maintaining the gaseous fluid pressure and simultaneously raising said pipes in successive stages to forcibly emplace the concrete in the well to fill the same and thus form the built-in-place pile.

4. A method as set forth in claim 3, wherein the ground water within the well is displaced through the conduit pipe by the gaseous fluid pressure prior to the injection of the concrete.

5. A method of forming built-in-place concrete piles consisting in initially sinking a tubular reception pipe into the ground and excavating and removing therethrough the solid matter encompassed by the reception pipe to form a well, closing the upper end of the reception pipe to render the same fluid tight, extending a conduit through the closed upper end of the reception pipe in sealed relation thereto with the lower end of the conduit terminating adjacent the bottom of the well, introducing a gaseous fluid under pressure into the upper end of the reception pipe exteriorly of the conduit and forcing by said pressure the ground water upwardly through the conduit and discharging the same therefrom, injecting concrete through the conduit while maintaining the gaseous fluid pressure within the reception pipe, and then simultaneously raising the reception pipe and conduit in stages while continuing to inject the concrete and to maintain the gaseous fluid pressure so as to discharge the concrete into the well from the lower to the upper end thereof to form the built-in-place pile.

6. In a method as set forth in claim 5, wherein the gaseous fluid pressure is varied to compensate for variations in the resistance and density of the ground strata through which the well extends.

7. A method as set forth in claim 5, wherein the reception pipe and conduit are made up of coupled sections and which are added as the sinking of the well progresses and which are removed as they are raised during the building of the pile.

8. A method as set forth in claim 5, in which the gaseous fluid pressure is utilized in effecting the raising of the reception pipe during the formation of the pile within the well.

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9. A method of forming built-in-place concrete piles which includes the steps of initially forcing into the ground a tubular shoe attached to the lower end of a reception pipe of lesser cross-sectional size than the shoe to form a well of greater cross-sectional size than the reception pipe, removing through said reception pipe the solid material encompassed thereby, closing the upper end of the reception pipe to render the same fluid tight, extending a conduit through the closed upper end of the reception pipe in sealed relation thereto with the lower end of the conduit disposed adjacent the lower end of the shoe, introducing a gaseous fluid under pressure to the upper end of the reception pipe outside of the conduit and initially forcing the ground water in the well upwardly through the conduit and discharging the same therefrom by said pressure, increasing the pressure and raising the shoe to-

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gether with the reception pipe and conduit while simultaneously injecting concrete under pressure to force said concrete from the lower end of the reception pipe into the bottom of the well to form a laterally expanded footing of greater cross-sectional area than the well, then reducing the pressure while continuing to raise the reception pipe and simultaneously injecting the concrete under pressure into the well to fill the same and form the built-in-place pile therein.

10. A method as set forth in claim 9, in which the upper end portion of the shoe is tapered inwardly and upwardly and functions to restore to its original cross-sectional size and shape any distorted portions of the wall of the well as the reception pipe is raised during the building of the pile.

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