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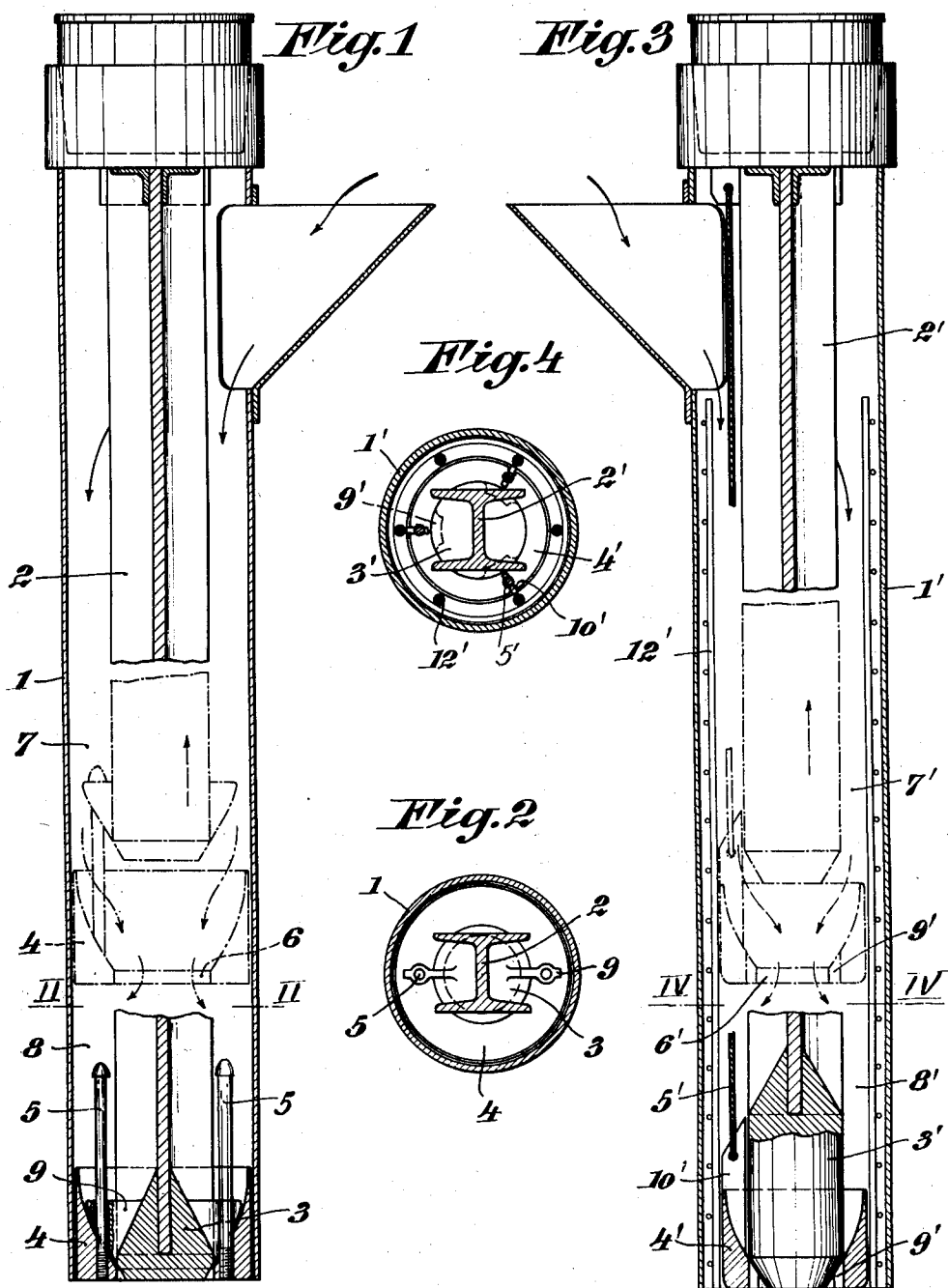
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APPARATUS FOR FORMING COLUMNS IN SITU

Filed Aug. 8, 1932

3 Sheets-Sheet 1



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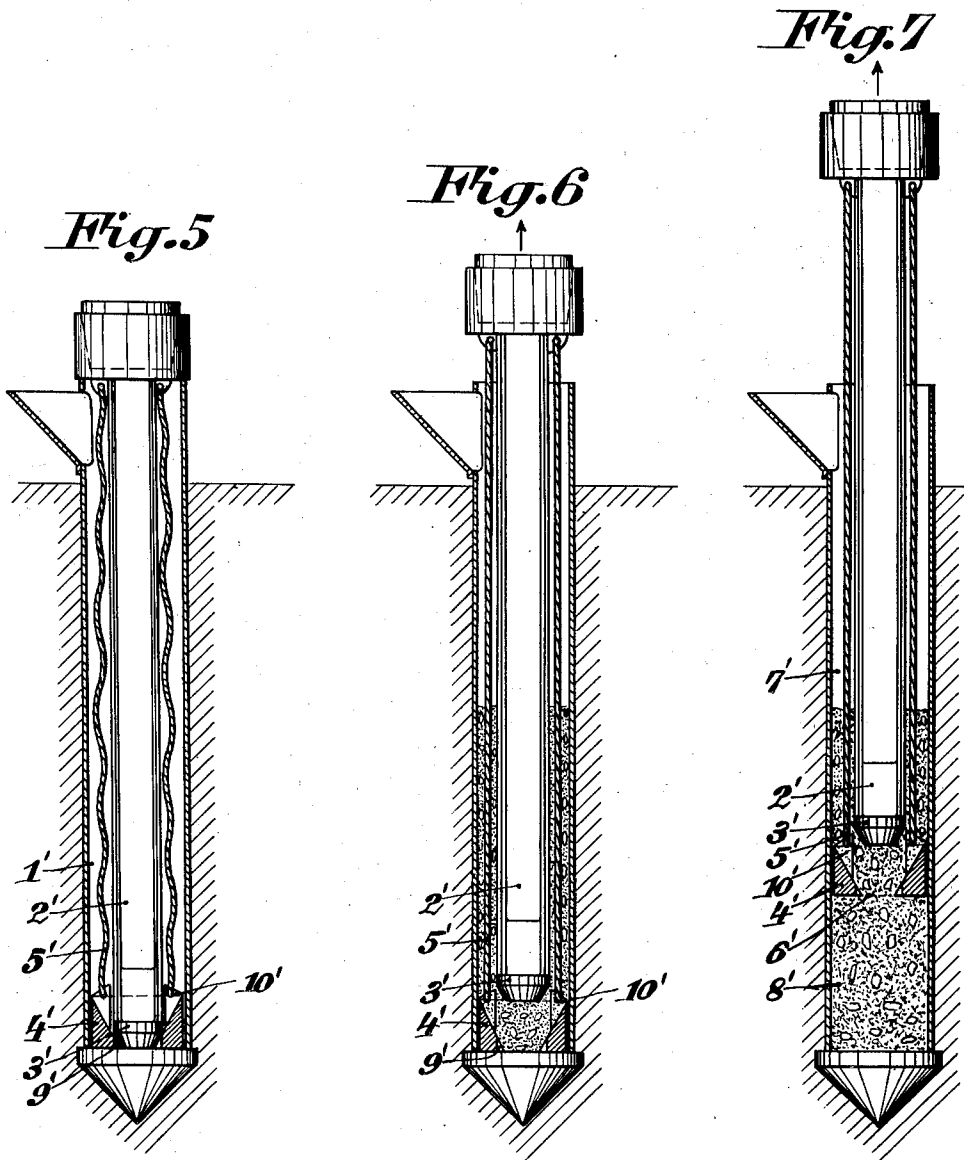
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3 Sheets-Sheet 2



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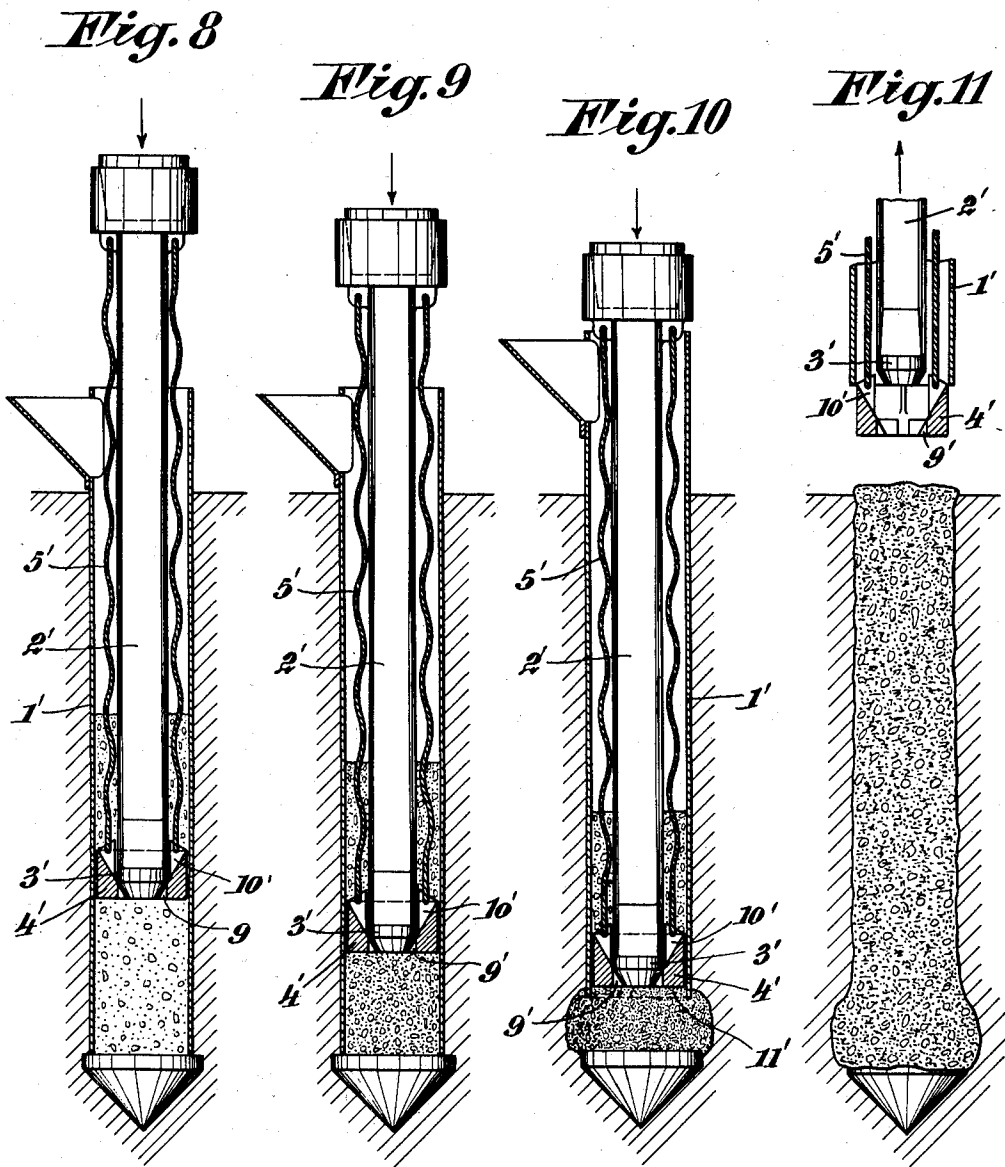
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APPARATUS FOR FORMING COLUMNS IN SITU

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3 Sheets-Sheet 3



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## UNITED STATES PATENT OFFICE

1,978,332

APPARATUS FOR FORMING COLUMNS  
IN SITU

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Application August 8, 1932, Serial No. 627,983  
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5 Claims. (Cl. 61—57)

This invention relates to an apparatus for the production in situ of columns of porous or solidified materials in the ground and more particularly relates to the production of concrete piles.

5 The invention contemplates the production of columns of compressed or solidified material (piles) as well as columns of a porous nature. The columns may be of any length and any desired diameter. They may be of uniform diam-  
10 eter or with widened (bulbous) portions at the bottom or at intermediate portions. As examples of the kinds of porous columns to which the invention applies there may be mentioned: the sand and rubble filters in water supply installa-  
15 tions, more particularly from river areas where the withdrawal instead of being effected from open wells is with advantage effected from shafts driven into the ground which are filled with sand or rubble; the drainage shafts in agriculture  
20 drainage systems in which, by means of rubble-filled deep shafts, the drainage of large areas can be effected by their vertical connection with a gravel bed at a still lower level far more effectively than by a network of ditches and canals;  
25 the improvement of building land by means of columns made in situ, formed of rubble or gravel with or without a binding agent, which when produced by other means mostly not only entails an expenditure of much time and is costly, but  
30 are also more or less unreliable in operation.

The invention consists in an apparatus for the production in situ of columns in the ground which includes a tube, a rod, a plunger affixed to or integral with said rod and a follower associated  
35 with said plunger and adapted to move therewith after a time interval, the said plunger and follower sliding more or less tightly within the tube.

The present invention is more fully described below with reference to the accompanying drawings which illustrate examples of how the invention may be carried into effect. In these drawings:—

Figures 1 and 3 show in sectional elevation two different constructions of the apparatus according to the invention. Figures 2 and 4 are cross-sections taken on line II—II of Figure 1 and IV—IV of Figure 3 respectively. Figures 5 to 11 illustrate various stages of the method of building piles with an apparatus according to the present invention.

The apparatus shown in Figures 1 and 2 consists of a smooth, uniform diameter tube 1 and a rod 2, provided at the bottom end with a plunger 3 which is connected with a follower 4 by means  
55 of two guide-rods 5 screwed into said follower

and ending in headed portions at their top ends. At both sides the plunger 3 is provided with jaws 9 (Fig. 2) or the like provided with vertical bores through which extend the guide-rods 5, so that the plunger 3 can be lifted for the length of the guide-rods 5 without taking with it the follower 4. The latter is raised during the upward stroke of the plunger 3 only when the jaws 9 co-operate with the headed portions of both guide-rods 5.

The raised position of plunger and follower is indicated in dotted lines. Now if in this position concrete is poured into the funnel located at the top end of the tube 1, the concrete drops down the space 7 and through the bore 6 of the follower 4 (which now is uncovered by the plunger 3) into the bottom space 8 of the tube, this operation being facilitated considerably by the upward movement of the parts 2, 3 and 4.

During the downward movement of the rod 2 first the annular follower 4 settles down on the concrete charge in the compression chamber, then the plunger 3 closes the opening in the follower 4, the jaws 9 finally co-operate with the follower 4 and move it down.

Figures 3 and 4 illustrate a modified construction of the apparatus according to the present invention. In this construction also the rod 2' with the plunger 3' at its bottom end is movable up and down in the tube 1'. However, in this construction the plunger 3' is of cylindrical shape, guided by ribs 10' (for instance three ribs, Fig. 4) of the follower 4'. The connecting member 5' between the follower 4' and the rod 2' is in the form of wire ropes or chains which, as illustrated, may extend up to the head of the rod. The jaws 9' are arranged on the follower 4'. During its downward movement the plunger 3' co-operates with and moves down the follower 4'.

When the apparatus is to be used for the production of reinforced concrete piles, the outer diameter of the follower is smaller than the inner diameter of the tube. The free annular space around the plunger must be large enough to permit the ready arrangement of the reinforcing cage 12' so that it will not obstruct the up and down movement of the follower (Fig. 4).

The procedure for filling concrete into the top space 7' above the lifted plunger 3' and follower 4' is the same as described with reference to Figures 1 and 2.

Now will be described the method for the production of concrete piles, by an apparatus according to the invention, reference being made to Figures 5 to 11.

The tube 1' is sunk to the depth required (Figure 5) in any convenient manner, for instance by driving, the blows being applied in known manner directly to the rod 2' and the pile shoe remaining permanently in the ground in order to spare the tubing 1'.

Now concrete is filled into the tube 1' (Figure 6) and the rod 2' lifted slightly. Whenever a sufficient quantity of concrete is present in the tube 1', the rod 2' is rapidly lifted for some distance (Figure 7), whereby the follower 4' is lifted for some distance with the plunger 3'. Now the concrete drops from the top space 7' of the tube 1' and through the bore 6' of the follower 4' into the bottom space 8' of the tubing. Hereafter the rod 2' is driven down (Figure 8) until the concrete underneath the plungers has been compressed to the desired density (Figure 9). In view of the continuous blows applied to the rods the concrete is forced out laterally of the tube whereby the latter is forced upward and a concrete enlargement 11' is formed at the base of the column (Figure 10).

The pile is gradually erected (Figure 11) by repeating this procedure, whereby the tube is stepwise pulled out. In Figure 11 the tube 1' is entirely pulled out and the follower 4' is freely suspended so that it is readily accessible for inspection and cleaning.

The plunger and follower arrangement described above renders it feasible to conduct concrete into the compression chamber 3' through the passage between the plunger 3' and follower 4' by lifting the rod 2' and thus to get the concrete below the tamping surface of the follower 4' without extracting the rod entirely from the tube. Notwithstanding, when letting down the rod, the plunger 3' and follower 4' form an uninterrupted tamping surface covering the entire cross sectional area of the tube, allowing the concrete to be pressed equally all over this area. Thereby the production of compressed concrete piles is considerably simplified compared with the use of an implement with a tamping rod of a diameter equal to the inner width of the sinking tube, which has to be entirely extracted from the tube when pouring in concrete and then lowered again into the tube for tamping the concrete.

The plunger and follower arrangement described above possesses the further advantage that the height of the compression chamber can be chosen such as to allow of leaving, after each charge of filling material forced out from the tube during the concreting of a pile, a plug of compressed concrete within the bottom end of the tube for the purpose of neutralizing any existing pressure of soil or sealing the tube against influx of artesian ground water. The height of this concrete plug can be adapted to the height of the actual soil pressure by actuating the filling and tamping work at a higher or lower level of the sinking tube.

This method alone makes possible the reliable production of concrete piles cast in situ, without permanent casing, on building sites where pressing soil or even artesian subsoil water is encountered.

Besides, obstructing the passage of the follower by concrete masses is entirely prevented. For when lifting the plunger 3 the entire filler column has to be accelerated if it does not automatically and immediately pass into the bottom space or compression chamber of the tube through the opening 6 of the follower. The head imparted

to the filler column by its acceleration, in addition to the frictional adherence of the filling material to the outer tube, results in the breaking up of all too cohesive filling materials and of obstructions, and consequently the filler is bound to flow through the opening 6 of the follower. A blocking or obstruction is thus avoided even in the case of materials such as sand and stiff concrete.

A further advantage of the apparatus according to the invention, is that the rod 2 with the plunger 3 when descending substantially shuts the opening 6 of the follower 4. The effect of this is that, on one hand, a compression chamber is created underneath the follower 4, namely a space which is closed on top, and on the other hand, any formation of a bridge over the opening 6 and consequent obstruction of the latter, is prevented. In this manner filling material of any consistency, even fluidity, may be placed under pressure and forced out of the bottom end of the guide tube without being able to escape upwards.

In order that as much as possible of the clear width of the upper space of the tubing may be available for the filling material, the rod 2 is preferably made in known manner of buckling-resistant rolled section iron, for example a broad-flanged I-iron which causes but a very small loss of space.

The improved effects of the apparatus described as compared with the means hitherto used consists not only in the greater economy in sinking as compared with other building in situ methods, but also in the circumstance that the sinking of shafts of relatively small diameter suffices since the columns can be widened, by pressing, to a greater diameter. This widening is possible in nearly every kind of ground, all that is necessary being to employ a greater mechanical energy for a longer period of time when it is a question of overcoming the greater external resistances.

By way of further explanation it may be stated that in soft earths the weight of the rod 2 alone with that of the hammer resting on it frequently suffices for effecting one operation of the plunger to its full stroke. In this case the filling material which has passed into the pressure space 8 can without any difficulty produce a displacement of the earth by the amount of the plunger displacement and be extruded to a corresponding extent out of the pressure space. If the pressing operation be continued the resistance of the more and more compressed mass of material will naturally become greater and greater and it will then become necessary for producing complete compression strokes of the plunger to increase the plunger pressures by blows with a more or less heavy block or hammer.

It is obvious that in those cases where the deposited layers are formed in the first instance it will be necessary to expend from the start a greater pressing energy of the plunger. In all circumstances, however, by applying a suitable amount of mechanical work at any desired points it is possible to produce widening in the column.

What I claim and desire to secure by Letters Patent of the United States is:—

1. In an apparatus for the formation of columns in situ, the combination of a column-forming tube, with a plunger, an operative rod therefore movable in the tube, said plunger having a cross-area less than that of the tube to provide an annular passage therebetween, a follower in the tube below the plunger and provided with an

axial passage, and means providing a loose connection between the plunger and the follower to limit the separation of the same to a predetermined interval when the plunger is raised in the tube.

2. An apparatus as claimed in claim 1 and comprising a tube having a smooth inner surface and uniform diameter and a rod having an I cross-section.

10 3. An apparatus as claimed in claim 1 and comprising a plunger having a lower surface of a

truncated cone, a follower having a vertical conical passage, so the plunger may fit substantially into the follower.

4. An apparatus as claimed in claim 1 and comprising a loose connection consisting of guide rods screwed into the follower and having headed portions at the upper ends. 80

5. An apparatus as claimed in claim 1 and comprising a loose connection consisting of lines extending from the follower to the rod. 85

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