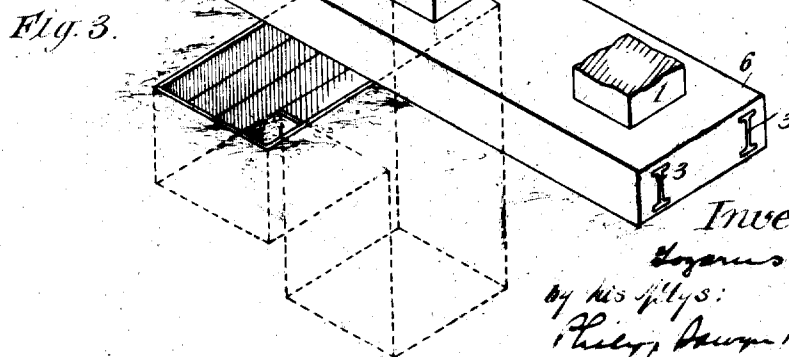
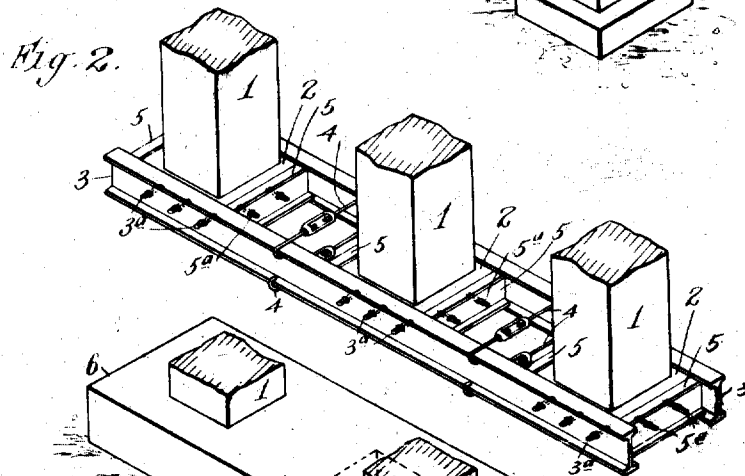
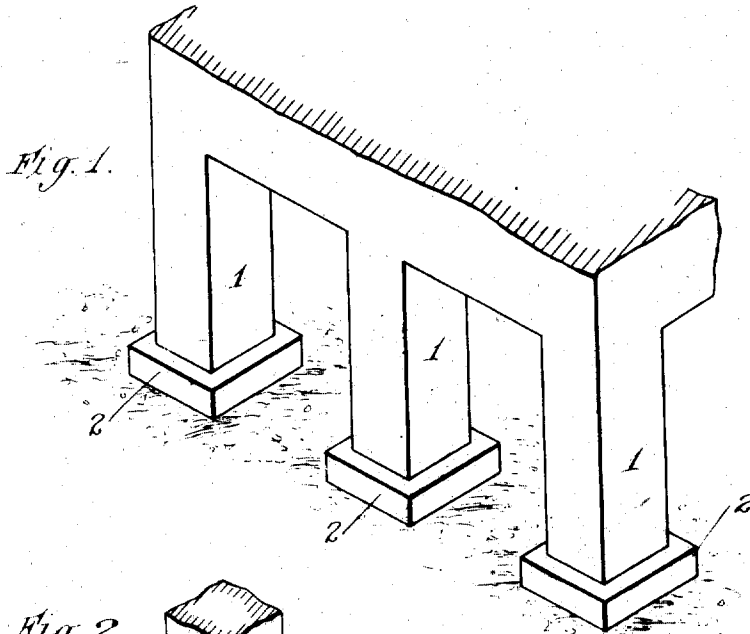


L. WHITE.
METHOD OF PROVIDING SUBSTRUCTURES FOR STRUCTURES.
APPLICATION FILED MAR. 10, 1916.

Patented Feb. 20, 1917.
3 SHEETS—SHEET 1.

1,217,128.



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3 SHEETS—SHEET 2.

Fig. 4.

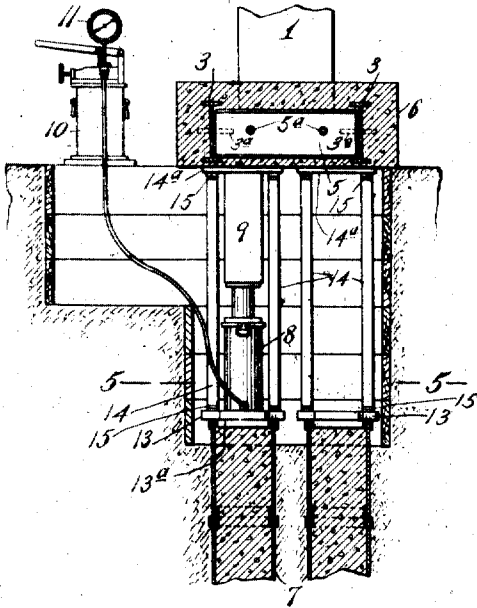


Fig. 6.

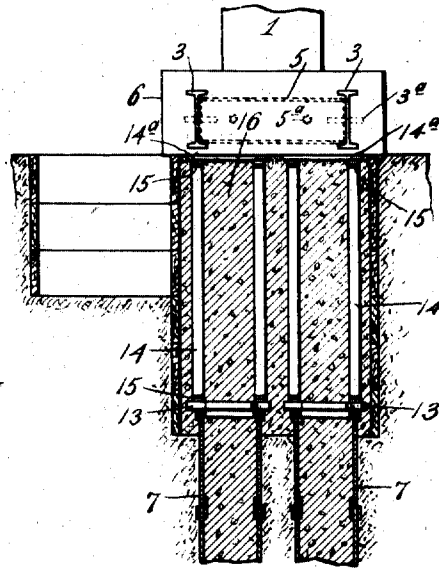
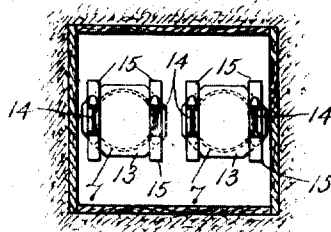


Fig. 5.

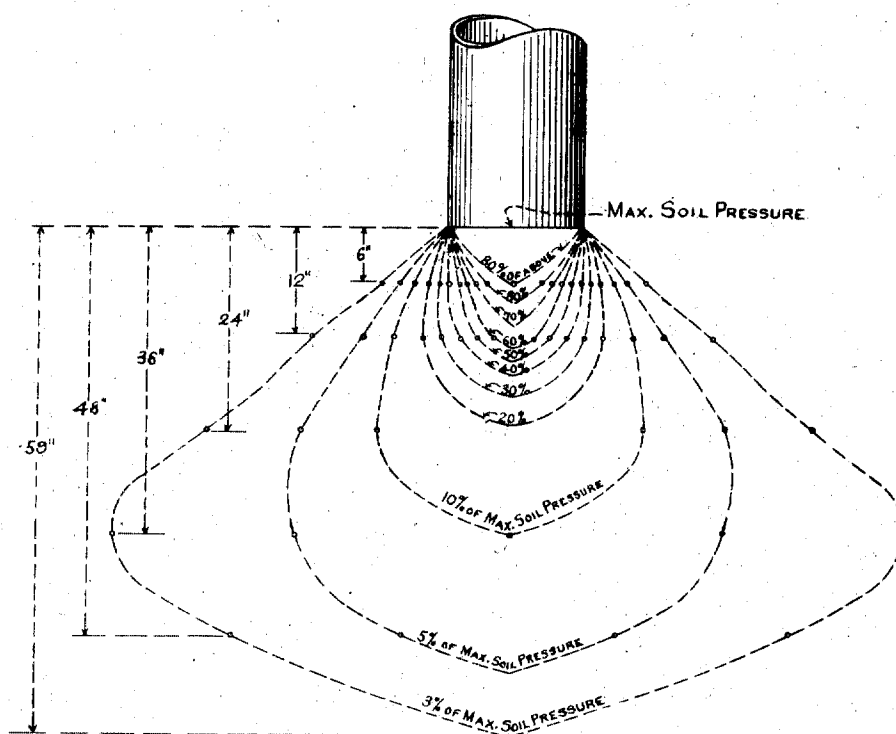


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Fig. 7.



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UNITED STATES PATENT OFFICE.

LAZARUS WHITE, OF NEW YORK, N. Y.

METHOD OF PROVIDING SUBSTRUCTURES FOR STRUCTURES.

1,217,128.

Specification of Letters Patent.

Patented Feb. 20, 1917.

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To all whom it may concern:

Be it known that I, LAZARUS WHITE, a citizen of the United States, residing at New York, county of New York, and State of New York, have invented certain new and useful Improvements in Methods of Providing Substructures for Structures, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to an improved method of providing substructures for structures, as for example in constructing foundations for buildings being erected, or underpinning foundations of buildings already erected.

In underpinning foundations, it has been a common practice in the art heretofore to sink piles either adjacent to or immediately beneath the foundation walls of a building, and then after the piles have been sunk to insert between each pile and the building suitable members which transmit a part of the weight of the building to the piles.

In such prior practice of underpinning, the great difficulty has arisen that a settlement of the piles under the load generally occurs. Such a settlement can not be predetermined and is generally different for different piles which are used in underpinning the building. The result of this is that the building walls are likely to be cracked and the entire building structure injured.

The object of the present invention is to provide a method for supplying a structure with a substructure, which method will overcome the uncertainties of the previous methods of constructing foundations or of underpinning structures, and thereby will avoid the various difficulties and disadvantages resulting from the settlement and particularly the uneven settlement of the building during the progress of the erection of a structure or the work of underpinning and after the same has been completed. The method, however, is not limited to underpinning in the restricted sense of that term as applied to the reinforcement or carrying deeper of foundations of buildings already erected. The new method is applicable for providing a substructure at any time, including the time of the erection of a building or other structure.

With this general object in view, the pres-

ent invention broadly considered consists in sinking a footing, generally a pile, to the desired extent, subjecting the same to a test load giving a downward pressure at least equal to, and generally considerably in excess of, the load which such pile or other footing is intended to carry permanently, and while such pile or other footing is under this predetermined and known load, transferring the final or permanent load to such pile or other footing. In the best embodiment of the invention, the transfer of the building load to the pile or other footing is so carried out that such building load is gradually substituted for the predetermined and preapplied known load.

Hence, as all settlement of the pile or other footing under a load equal to the permanent or greater already occurred with the first application of the known test load, little or no further settlement will take place when the permanent load has been substituted for the load first applied.

In the best embodiment of the invention, the first or temporary load is obtained by using the building or its old foundation above the pile or other footing as a reaction or abutment for pressure applying means which can gradually apply a load to the pile or other footing, so that the first or temporary load on the pile or other footing may be greater than the desired portion of the weight of the building which such pile or other footing is to carry finally. Furthermore, in the best embodiment of the invention this first or temporary load is so applied to the pile or other footing that it can be measured or predetermined, and thereafter, if necessary, can be gradually removed as the permanent load of the building is gradually applied.

The invention will be more specifically described hereinafter in connection with the accompanying drawings explanatory of the specific application of the method to the underpinning of a building assumed to be already erected.

In the drawings—

Figure 1 is a detailed perspective view illustrating a typical 3-pier foundation with the earth excavated from around the piers;

Fig. 2 illustrates the same foundation with an incomplete grillage applied;

Fig. 3 is a similar view illustrating the

grillage completed and a pit started beneath the grillage;

Fig. 4 is a vertical sectional view showing one of the columns completed and the other in course of insertion;

Fig. 5 is a horizontal section on the line 5-5, Fig. 4, and

Fig. 6 is a transverse vertical section showing the completed underpinning;

Fig. 7 is a diagrammatic view illustrating one theory as to the action of a loaded pile upon the soil at its lower end.

It is to be understood that this improved process is applicable for providing a sub-structure for any kind of structure as well as for providing underpinning for structures having any kind of foundation. In the present application, the process is described as it would be carried out in underpinning a building having a pier foundation, since this is typical of the foundations usually encountered where the matter of underpinning is a serious problem.

Referring to the drawings, Fig. 1 illustrates part of a building which is supported on three piers 1, resting upon foundation slabs 2.

As will be understood by those skilled in the art, the piers and foundation slabs are buried in the ground. In preparing to underpin such a building, the earth is excavated from around the piers and down to or near the level of the bottom of the foundation slabs.

Then suitable girders, such as, for example, I-beams 3, are placed at each side of the foundation slabs, one on the outside of the foundation and the other on the inside. The two girders, 3, are held together in a suitable way to clamp the slabs, 2, firmly between them. This can be conveniently done by binding the girders together by clamps, 4, between the piers.

In order to make a good connection between the said I-beams, 3, and the foundation slabs 2, they may be doweled together as by means of dowel pins 3^a passing through holes in the I-beams and into holes drilled in the foundation slab.

The transverse faces of the slabs are tied to suitable channels or I-beams, 5, whose ends are carried by the longitudinal girders, 3. The connection in this case also may be by dowel pins, as indicated at 5^a. The structure at this stage is indicated by Fig. 2. Concrete is then applied to form a solid block or slab inclosing the longitudinal girders, 3, and the transverse beams, 5, so that the whole constitutes a solid grillage at the foot of the piers. This concrete is indicated at 6, Fig. 3.

A pit is then dug between the piers, and, if necessary, carefully sheeted, preferably horizontally, this pit being carried down as far as desired and generally until ground

water makes further progress impossible. From the level of the bottom of this pit sectional metal pile-tubes are driven downward. In the usual practice, the sections of tubing, usually about two feet in length, are pressed down by a hydraulic jack arranged to react against the grillage of the building foundation, as will be clear from Fig. 4, where 7 indicates the section of pile tubing, 8 the hydraulic jack, and 9 a suitable blocking between the top of the jack and the bottom of the grillage. When a length of tubing has been completely driven, the material from its interior is suitably removed, another length of the tubing is added and the jack load reapplied to drive the tubing farther. When one pile has been driven to the required depth, others are then driven. It is customary to drive one pile at each corner of a pit of the ordinary size, though, of course, the number of piles and their locations are determined in accordance with engineering requirements.

After the required number of piles have been driven in the pit and properly cleaned, the piles are filled with concrete. As soon as this has been done, a suitable known test load is applied to each pile, it being important to have the test load in excess of the permanent load which is subsequently to be applied to the pile.

In the best practice of the invention, this test load is about 50% greater than the final load apportioned to the pile. Most advantageously this test load is applied by means of a hydraulic jack bearing against the head of the pile, and reacting at its upper end against the bottom of the grillage, because with a jack of suitable size, as indicated at 8, Fig. 4, and a pump 10 with a pressure gage 11, any desired load may be gradually applied to the pile, and in case the pile settles under such test load, the load can still be maintained at the desired predetermined amount during such settlement by further operation of the pump to maintain the pressure in the gage at the point determined upon.

The pile is maintained under the test load until finally it will carry that load with no settlement for a suitable period of observation.

At the end of this period, the proportionate load of the building which the pile is to carry permanently, and which, as before explained, is less than the test load, is now transferred to the pile without at any time releasing the pile from a load at least equal to the said permanent load. This may be done as hereinafter explained. The reason for this is that it has been found that if a pile, be driven to a point where no settlement will occur under a given load, the pile will again settle farther to a material extent, if the said load be removed and the

same/reapplied. Hence, by repeatedly removing and replacing a substantial load on a pile, a considerable settlement of the pile may be obtained, and so far as has been found in practice, this action will continue as often as the load is removed and replaced.

This is probably due to the fact that the soil under and adjacent to the pile is compacted under the pressure to which the pile is subjected by the test load, and upon a removal of this load loses its compacted condition and disintegrates.

It has been found that a pile driven into soil will carry, without settlement, a load in excess of that attributable to the resistance of the area of the end of the pile. Some investigation which has been made indicates that probably a bulb of compressed soil forms at the bottom of the pile. Fig. 7 is a diagrammatic view intended to illustrate the manner in which such a bulb is formed, the curved lines at the base of the pile indicating the extent of the pressures determined by some experiments which have been made. The figures accompanying the respective lines give the observed pressures for the corresponding pressure lines. It is assumed that the compression of the soil to a distance beyond the periphery of the pile at the lower end assists in carrying the load on the pile. Furthermore, it appears that there is a rebound of the pile when its load is removed and this rebound has been found to be greater than could be attributed to the mere expansion of the pile itself. Consequently it seems that probably the compressed soil at the foot of the pile has some elasticity which assists in the rebound of the pile. If this be true it would explain why a pile once driven under a given load to a point where no further sinking takes place can, when released from that load, again be driven farther upon reloading the pile even to a lesser extent than it was loaded before. It is probable that the compressed bulb of soil breaks up when the pile is unloaded so that, upon the reapplication of a load, the pile must sink deeper until it again forms a new bulb of soil beneath its lower end.

Hence, in order to avoid settlement of the pile under the permanent load, it is important that such load be applied to the pile after the test load has been applied, and without any intermediate non-loaded condition of the pile. That is to say, from the time the pile has reached its condition of non-settlement under the test load until the permanent load is fully upon it, the pile should be continuously held under load and most advantageously under a load as great as said permanent load.

In practice, this important operation is conveniently carried out by erecting a column between the head of the pile and the bottom of the grillage while the pile is still

held under its test load, and then wedging this column so as to transfer to it and thereby to the pile, the required permanent load. The wedging action, of course, will release all or a portion of the test load, so that at no time is the pile subjected to any greater load than the test load, and, on the other hand, at no time is it subjected to any load materially less than that which it is to carry permanently.

It is advantageous and in most cases important to make sure that the permanent load applied to the pile is not less than that which it is intended to carry. Therefore, the column inserted between the pile and the grillage is of metal such as steel and of such a section that the amount of its compression under the required load may be determined in advance. Then when wedging up the column to take its permanent load, the amount of compression may be measured by known methods and when it is equal to the amount of compression corresponding to its permanent load, the wedging operation is terminated.

As it is generally customary to apply the test load by a hydraulic jack placed directly in line with the pile, it is necessary to make some provision for placing the column between the pile or other footing and the grillage while the jack is still in place. As one simple way of doing this, a cap 13 is provided for the pile, this cap 13 extending laterally beyond the pile, on which lateral extensions two compression members 14 of suitable steel shapes may have their footings. These members are cut of the length required and are put in place with a plate member 14^a over them, this plate member bearing against the bottom of the grillage. Wedges such as indicated at 15 are inserted between the tops of the column members and the said plate members, and between the bottoms of the column members and the caps 13. These wedges are then driven up until the required load comes onto the column members. The jack and its blocking are then removed.

When the footing is a pile, the cap 13 at the top of the pile has a circular boss 13^a projecting downward and of a diameter less than the interior diameter of the top of the pile, so that the load on the caps is transmitted directly to the concrete of the pile instead of onto the tubular casing.

When all of the piles or other footings and their column members are in place and wedged up, so as to receive their respective permanent loads, all of the column members are inclosed by a body of concrete 16 extending from the heads of the piles or other footings to the under side of the grillage, this being done by filling with concrete the sheeted pit containing the piles or other footings.

The operations hereinbefore described are repeated until the grillage is underpinned to the extent required.

An important advantage of the present invention is that the footings may be given an adequate load, so that the number of such piles or other footings for a given building may be materially reduced.

What is claimed is:

1. The method of providing a substructure for structures which comprises setting a footing, loading it with a temporary load, maintaining it under such temporary load until settling of the footing ceases, and then exchanging the temporary load for a permanent load, the footing being maintained under load during the exchange.

2. The method of providing a substructure for structures which comprises setting a footing, loading it with a known temporary load, maintaining it under such temporary load until settling of the footing ceases, and then exchanging the temporary load for a permanent load, the footing being maintained under load during the exchange.

3. The method of providing a substructure for structures, which comprises setting a footing, loading it with a temporary load, maintaining it under such temporary load until settling of the footing ceases, exchanging the temporary load for a permanent load, and during such exchange maintaining the footing under a load not greater than said temporary load.

4. The method of providing a substructure for structures, which comprises setting a footing, loading it with a temporary load, maintaining it under such temporary load until settling of the footing ceases, exchanging the temporary load for a permanent load, and during such exchange maintaining the footing under a load not greater than said temporary load, and not less than said permanent load.

5. The method of providing a substructure for structures, which comprises setting a footing, loading it with a temporary load, maintaining it under such temporary load until settling of the footing ceases, exchanging the temporary load for a permanent load, less than the temporary load, and during such exchange maintaining the footing under a load not greater than said temporary load, and not less than said permanent load.

6. In a method of underpinning structures, the process which consists in sinking a footing below the structure to be underpinned, temporarily submitting the footing to a load not less than that of the permanent load which said footing is to carry, retaining said temporary load until settlement of the footing ceases, and then transferring the permanent load to said footing, and during the transferring maintaining the footing un-

der a load not materially less than its permanent load.

7. In a method of underpinning structures, the process which consists in sinking a footing below the structure to be underpinned, temporarily submitting the footing to a load not less than that of the permanent load which said footing is to carry, retaining said temporary load until settlement of the footing ceases, and then transferring the permanent load to said footing, and during the transferring maintaining the footing under a load not materially less than its permanent load and not materially greater than its temporary load.

8. In a method of underpinning structures, the process which consists in sinking a footing below the structure to be underpinned, temporarily submitting the footing to a load in excess of the permanent load which said footing is to carry, retaining said temporary load until settlement of the footing ceases, and then transferring the permanent load to said footing, and during the transferring maintaining the footing under a load not substantially less than its permanent load.

9. In a method of underpinning structures, the process which consists in sinking a pile below a portion of the structure to be underpinned, applying a hydraulic action to said pile and the corresponding reaction to the structure to produce a pressure on the pile in excess of the permanent load which said pile is to carry, maintaining said pressure on said pile until settlement of the pile ceases, and then transferring the permanent load to said pile while maintaining said pile under pressure.

10. In a method of underpinning structures, the process which consists in sinking a pile below a portion of the structure to be underpinned, applying a known hydraulic action to said pile, and the corresponding reaction to the structure to produce a pressure on the pile in excess of the permanent load which it is to carry, maintaining said pressure on said pile until settlement of the pile ceases, erecting a column between the pile and structure while maintaining said pressure on the pile, and wedging the column to transfer to it the desired load which it is to carry.

11. In a method of underpinning structures, the process which consists in sinking a footing below the structure to be underpinned, temporarily submitting the footing to a load in excess of the permanent load which said footing is to carry, inserting column members between the structure and the footing while said footing is maintained under said temporary load, and wedging said column members to transfer the permanent load to the footing, whereby the footing is

maintained under load at all times during the transfer to it of the permanent load.

12. In a method of underpinning buildings, the process which consists in sinking *separately* a plurality of piles below a portion of the structure to be underpinned, applying a known temporary load to each pile, and maintaining such pile under said temporary load until settlement of the pile ceases, then inserting a column between such pile and the structure, while retaining the pile under such temporary load, gradually transferring the permanent load which said pile is to carry to said pile while correspondingly releasing it from its temporary load, and when all of the piles of said plurality have received their permanent loads, inclosing all the columns with a mass of concrete.

13. The method of setting and loading a

pile consisting of placing the pile, submitting the pile to pressure great enough to compact the earthy material at its bottom sufficiently so that the pile will carry without further sinking the permanent load which it is to finally support, and maintaining such pressure while loading the pile with its permanent load, so that the compacted earthy material beneath its bottom will not disintegrate and permit any substantial sinking of the pile under its permanent load.

In testimony whereof, I have hereunto set my hand in the presence of two subscribing witnesses.

LAZARUS WHITE.

Witnesses:

PHILIP N. TILDEN,
JAMES F. DONOVAN.