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CONSTRUCTING FOUNDATIONS OF BUILDINGS.

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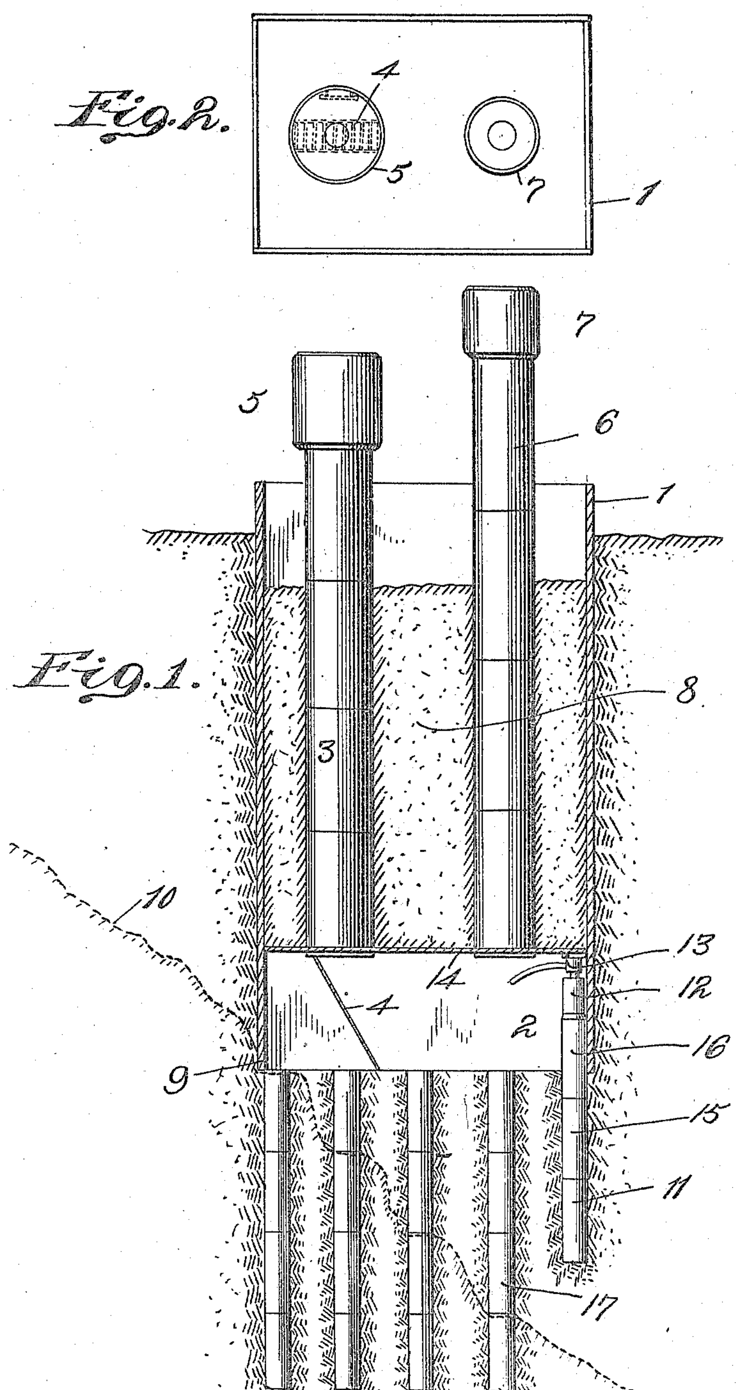

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CONSTRUCTING FOUNDATIONS OF BUILDINGS.

957,844. Specification of Letters Patent. Patented May 10, 1910.

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To all whom it may concern:

Be it known that I, JULES BREUCHAUD, a citizen of the United States, residing at Yonkers, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Constructing Foundations of Buildings, of which the following is a full, clear, and exact specification.

My invention relates to an improvement in the construction of foundations for buildings and is also applicable to improvements in the underpinning or provision of new supports for existing walls, as well as to the foundations for piers, bridges, and other structures.

An object to be accomplished by my invention is the extension of a foundation downward to a more secure or firmer foundation, at the same or different levels, in several sections.

In sinking caissons to serve as a foundation for a structure to be erected, it occasionally happens that such caissons—which are usually sunk by the pneumatic process—are required to reach a greater depth in order to rest upon a secure substratum than is available by the use of the pneumatic process. The pressure of air is employed in such cases for the purpose of excluding water from the caisson, as the admission of such water not only renders it uncomfortable for workmen who are employed to remove the soil, but also tends to disturb the adjacent earth and may occasion a subsidence, disturbing the foundations of adjoining buildings, and it is unsafe for men to work under a pressure of air greater than is required to exclude water at a depth of about one hundred feet. It also frequently happens that caissons are sunk to rock, and it is discovered that their lower edge rests upon a shelving or sloping rock. In such case the removal of the rock by hand in order to secure a level foundation for the caisson may be a very tedious matter, as the caissons are frequently of large size, and in both of these cases it is highly desirable to provide means whereby, when the caisson has been sunk as far as practicable or desirable without yet reaching a footing capable of supporting the load which the caisson is destined to bear, that means should be provided whereby the footing may be practically and simply extended to a secure foundation.

My invention relates to a new and improved method of constructing foundations and has for its object to provide means whereby foundation caissons may be employed in cases where they would otherwise be inapplicable, by providing sectional and separate supports for said caissons which may be forced to a firm support beneath said caissons and thereafter connected thereto. In connection with this method I may, if desired, employ the method of forcing down such sectional supports forming part of my Patent No. 563,130, or other means hereinafter described may be employed.

My invention, therefore, consists in the construction, beneath the lowermost part of a foundation caisson, of a plurality of smaller sectional caissons or supporting elements which are driven into the soil separately, directly beneath the said principal caisson, until they individually reach a firm foundation, after which they may be treated in the manner hereinafter set forth and connected to the foundation caisson so as to support the same. This and other features of my invention are fully described in the following specification and are illustrated in the accompanying drawing wherein—

Figure 1 is a sectional elevation of a foundation caisson employing my invention; and Fig. 2 is a top view of the same.

The caisson 1, which may be of wood or steel construction such as is usually employed, is provided at its lower extremity with the usual working chamber 2, filled with air under pressure, and in which workmen are employed to remove earth to facilitate the sinking of the caisson. Said working chamber 2 is provided with the usual ladder-well 3, reached by ladder 4, having passenger-lock 5, as well as a material-well 6, provided with material-lock 7. The space above the working chamber and within the walls of the caisson is filled with material 8, the weight of which causes the caisson to sink and furnishes the eventual column for supporting the building.

In the caisson illustrated I have shown the cutting edge at 9 of the caisson to have reached a depth which may be assumed to be as far as it is practicable to sink such caisson. The footing may, however, be one

which is not adapted to support the load which the caisson is designed to carry, and I provide means whereby supports for the caisson may be extended to a firm substrata which is capable of supporting such load and which supports in themselves possess the requisite strength in the following manner: The caisson has been sunk in the usual manner by excavation within the working chamber. The side walls of the caisson will rest on the floor of the chamber for support if it is necessary, as it may be in wet soil and the floor of the chamber permitted to remain.

A section 11 of the cylinder is placed vertically upon the soil within the working chamber and immediately below the body of the caisson. A hydraulic or other jack 12 may then be located vertically between the upper edge of the section 11 and the caisson, block 13 being employed if desired, between the jack and the ceiling 14 of the working chamber. A manipulation of the jack will then drive the section 11 into the earth, blocking being employed if desired between the jack and the said section, and in succession additional sections 15, 16, are placed in position and sunk until the column finally rests upon the firm supporting strata, such as rock, hard pan, etc., as shown by the lower section of column 17. The ceiling 14 acts as a buttress for the jack, making available the weight of the caisson 1 as a resistance to the force of the jack, whereby the sinking of the sectional column is accomplished. If desired and feasible, air pressure may be employed within these cylinder sections, and a workman for the purpose of removing material as the cylinder is sunk. This air may be conveyed through pipes lowered through any one of the wells, as it should be at a greater pressure than the air in the working chamber according to the increased depth. Or the hydraulic method may be utilized in sinking said cylinders in connection with the jack. The employment of workmen will enable the surface of the rock to be leveled off to provide a lever bearing if sloping rock is encountered, but if this is not feasible, owing to the size of the cylinder, depth etc., such bearing may be obtained when the pipe has been cleaned out by forcing grout through the pipe and into the adjacent soil, thereby furnishing a body of cement firmly connecting the rock and the bottom of the cylinder.

When the several cylindrical sectional columns have been sunk to the desired depth they may be cleaned out, and if the hydraulic method of sinking has been employed, the water pumped out of them, a cement base constructed if desired, and the cylinders may then be filled with concrete, after which, if desired, their upper ends may be connected by I beams or other suitable material, whereby the working chamber 2 may be filled with concrete as usual, and the subsequent work of withdrawing the wells or filling them with concrete so as to provide a homogeneous or integral foundation proceeded with, as is usual where the bottom of the caisson itself rests upon a firm supporting strata. I have illustrated a rectangular caisson 1, but the particular form thereof is not material, as a cylindrical caisson might equally well be employed, and in fact are employed of very large dimensions.

My invention is equally applicable to the extension of an underpinning of an existing wall, in accordance with my said Patent No. 563,130. Here the cylinders employed usually do not exceed more than about three feet in diameter. In such case, as well as in cases employing a much larger foundation cylinder, where the extension of the foundation is desired by reason of the fact that its footing, when sunk as low as practicable by the pneumatic method, still does not reach a firm substrata, it may be extended by smaller pipes sunk by the hydraulic process as hereinabove described. In sinking such cylinders below the water level without the use of compressed air and by the hydraulic method, the water may fill the extended foundation cylinder, and this objection is overcome by inserting a quantity of cement or concrete which will set under water and fill the space adjacent to and surrounding the lower end of the sectional column forming the firm connection with the rock or other bearing hereinabove set forth, and when this has set so as to seal the bottom of the pipe or tube, the water may then be pumped out of it and it may be filled with concrete in the usual manner.

While the supplemental columns to support the caisson may be sectional, as illustrated, it will be understood that the object in making them sectional is to permit them to reach a greater depth than would be possible with sections of the size that could be handled within a caisson, should desirable or firm substrata be found only at considerable depth. Should this be found at a lesser depth, it is possible that single sections might be employed. Also, while I have shown hollow cylinders or hollow piles, it may in some cases be advisable to employ solid piles, sectional or not sectional, according to the depth to be reached, and such piles, if sectional, may be connected in any usual manner, as by threaded sleeves and such threaded sleeves may also be employed to connect the hollow sectional cylinders as illustrated in my Patent No. 563,130, and be situated either internally or externally; or such cylinder sections may be connected by bolts passing through internal flanges. My invention, however, is not limited to such

matters, which are within the skill of the engineer's calling, nor is it necessarily limited to the employment of the hydraulic or pneumatic method as an aid to the sinking of the cylinders.

In the drawing accompanying the application I have illustrated an instance (in full lines), where the caisson has been sunk either as far as is practicable by the use of compressed air, or as far as it is thought best under the circumstances of any particular case, and in which the cutting edge has not reached a firm substrata, and here the foundation is illustrated as having been extended to a firm substrata by the employment of sectional columns sunk in the manner described. By making use of the weight of the caisson to force down the sectional columns, I achieve this important advantage—namely, that there is always available to sink each sectional column, a much greater resistance, afforded by the weight of the caisson, than the particular column will ever be called upon to support, and consequently a desirable margin of safety is provided. For instance, assuming a rectangular caisson of considerable size—40 feet x 10 feet—and designed to support a load of five tons to the foot, or a total of two thousand tons—in such case it would be perfectly feasible to sink twenty-five sectional columns under the caisson. If they should reach bed-rock they would be capable of sustaining a load greatly in excess of that required, but if they should rest in hard pan or other firm substrata they may be sunk until a force of say one hundred and fifty tons to each column will have no further sinking effect, and, it will be seen, will have a supporting power of at least thirty-seven hundred and fifty tons, irrespective of their concrete filling and increased footing, and the total supporting power of the caisson will likewise be greatly increased by the footing of the caisson itself. This desirable result is made possible by the construction of the extended footings in columns sunk separately. It will also be observed that the great depth at which the columns will usually be employed tends to prevent disturbance of the adjacent soil and lessening of the skin resistance, although this is not relied upon for support, which is obtained from the footing of the column.

The sloping rock 10, shown in dotted lines on the drawing (Fig. 1), illustrates another condition which may be met with, and here the lefthand edge of the caisson rests directly on the rock, and the second, third, and fourth columns—counting from the left—have bearing upon the rock at the bottom of the first, second, and third cylindrical sections respectively.

While I have illustrated the cylindrical sectional columns as having been sunk by the use of jacks, employing the caisson as a buttress, cases might occur where this would not be feasible, and in such cases I may employ other means to sink such sectional columns, as, for instance, a steam, pneumatic, electric, or other power hammer capable of delivering a powerful blow within a limited area.

After the sectional pipes have been sunk to bed-rock or other firm substrata and it is desired for any reason to withdraw them, they may be extracted by any means well known to engineers capable of effecting such object as they are then connected, and in the well thus formed a supporting column be placed, as, for instance, an I beam of requisite length may be lowered through one of the wells, or sections of such beams may be lowered and connected, and when placed in the column well they may be incased in concrete; or a concrete column may be easily constructed, if of sufficient supporting power, directly in the well, or other reinforced concrete may be employed, and a solid pile so constructed from the footing of the caisson directly to such firm substrata. It will also be seen that my method of sinking supporting columns separately below the footing of a caisson may be applied in other ways, as by making direct use of the shaft of the wells. The well holes of the caisson are produced by a somewhat flimsy lining about which the concrete is poured or the bricks laid, and this is lined with a substantial cylinder formed of sections which are added and sealed together as the caisson is lowered, forming an air-tight shaft. These may be easily constructed of material capable of subsequently being used as a supporting column. When the caisson is sunk, instead of withdrawing such shafts, as is usual, they may be forced directly into the ground beneath the caisson, employing the weight of the caisson for this purpose. Here, however, owing to the presence of the upper end of the cylinder at the top of the caisson (after the removal of the air lock) it is preferred to secure the ends of a large stirrup to the caisson, its bight lying over the cylinder, and insert a hydraulic or other jack between the bight of the stirrup and blocking upon the head of the cylinder and sink the column by operating the jack. Additional sections may be added from time to time as required and when the column has been sunk to the required depth it may, if desired, be disconnected at the foot of the caisson and the upper part removed, and the lower part may be connected as above described. Obviously, as many wells may be formed in the caisson as there will be supporting columns required and of the desired diameter, and these well holes may, after the columns are connected, be filled with concrete. Or, if desired, a follower may be

employed, acting through such well holes in the caisson to sink columns below the caisson, in which case the sections may be added at the foot of the caisson, where the follower will engage the cylinder, the power to sink such columns being applied to the head of the follower above the caisson by a jack and anchored stirrup; or, if desired by a suitable hammer acting upon the head of the follower. In these several cases the pneumatic or hydraulic method may be employed as an assistance if desired.

While I have illustrated the use of cylindrical columns, solid columns or piles may in some cases be employed, in sections, if desired, and when so employed, connected together and sunk in the manner described, and connected to the caisson as set forth.

What I claim and desire to secure by Letters Patent is:

1. The herein-described method of constructing foundations, which consists in sinking a caisson into the soil and arranging a jack in engagement with the base portion thereof, in then locating a supporting element vertically beneath said caisson and jack and forcing the same into the earth until a firm foundation is reached, permitting the soil supporting the caisson to be otherwise undisturbed and subsequently removing the jack and connecting said supporting element and the supporting soil to the caisson.

2. The herein-described method of constructing foundations, which consists in sinking a caisson into the soil, in then arranging a hydraulic jack in engagement with the base portion of the caisson and successively driving column sections perpendicularly into the earth until a column is formed which reaches bed-rock or other firm strata, permitting the soil supporting the caisson to be otherwise undisturbed then removing the jack, and subsequently forming a pressure-resisting connection between the supporting soil, the upper end of the column and the base portion of the caisson, substantially as described.

3. The herein-described method of constructing foundations, which consists in sinking a caisson into the soil, in then arranging a hydraulic jack in engagement with the base portion of the caisson and successively driving column sections perpendicularly into the earth until a column is formed which reaches bed-rock or other firm strata, then removing the jack, and repeating this operation until a plurality of sectional columns is formed, each resting on a firm substrata, permitting the soil supporting the caisson to be otherwise undisturbed and subsequently forming an integral pressure-resisting connection between the supporting soil, the columns thus formed and the base of the caisson, substantially as described.

4. The herein-described method of constructing foundations, which consists in sinking a caisson into the soil, in then arranging a hydraulic jack in engagement with the base portion of the caisson and successively driving column sections perpendicularly into the earth until a column is formed which reaches bed-rock or other firm strata, permitting the soil supporting the caisson to be otherwise undisturbed then removing the jack, uniting the footing of the column thus formed to firm substrata by grout and subsequently filling the column and forming a pressure-resisting connection between the supporting soil, the column and the base portion of the caisson.

5. A foundation for a building or other structure, comprising a caisson sunk vertically into the soil, and foundation elements individually of less diameter than the caisson and collectively supporting such caisson extending vertically below such caisson through the surrounding soil to bed-rock or other firm supporting strata, and a pressure-resisting connection between such caisson and the foundation elements.

6. A foundation for a building or other structure, comprising a caisson sunk vertically into the soil, and a plurality of columns, each of smaller cross-section than the caisson extending therefrom through the soil to firm substrata and supporting the caisson by means of a pressure-resisting connection between the caisson and columns.

7. A foundation for a building or other structure, comprising a caisson sunk vertically into the soil, and a plurality of columns, each of smaller cross-section than the caisson extending therefrom through the soil to firm substrata, a footing at the base of each column, the said columns supporting the caisson by means of a pressure-resisting connection between the caisson and columns.

8. A foundation for a building or other structure, comprising a caisson sunk vertically into the soil, and a plurality of columns individually of less diameter than the caisson and collectively supporting such caisson extending vertically below such caisson through the surrounding soil to bed-rock or other firm supporting strata, and an integral connection between the several columns thus formed and the base portion of the caisson.

9. The herein-described method of constructing foundations, which consists in sinking a caisson into the soil and in then forcing individual columns of smaller area in cross-section into the soil directly beneath said caisson until a firm foundation is reached, and in then connecting the said columns to the caisson.

10. The herein-described method of constructing foundations, which consists in sinking a caisson into the soil and in then

forcing individual sectional columns of smaller area in cross-section into the soil directly beneath said caisson until a firm foundation is reached, and in then connecting the said columns to the caisson.

11. The herein-described method of constructing foundations, which consists in sinking a caisson into the soil and in then arranging a jack in position to employ the weight of the caisson as a resistance, in then locating a supporting element upon the soil beneath the caisson and jack, and connecting the jack and supporting column and forcing the latter into the earth by the operation of the jack until a firm foundation is reached, and subsequently removing the jack and connecting said supporting element to the caisson.

12. The herein-described method of constructing foundations, which consists in sinking a caisson into the soil and in then constructing a plurality of supporting columns, each of less area in cross-section than said caisson, beneath the same and extending to firm substrata, and in then connecting the columns thus formed to the caisson, substantially as described.

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