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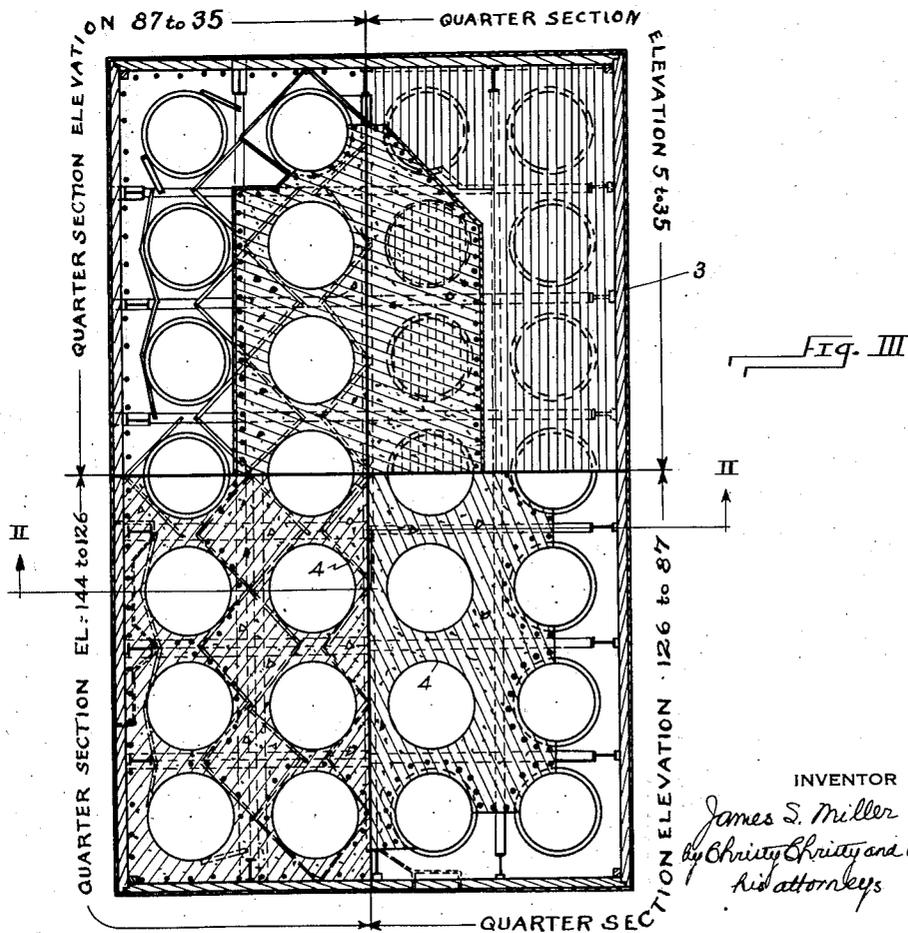
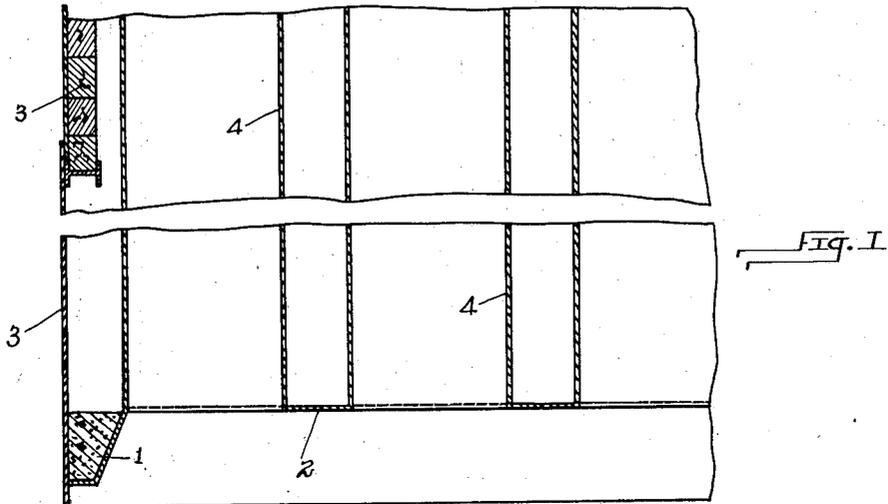
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SINKING OF CAISSONS AND THE BUILDING OF PIERS, ETC

Filed June 10, 1932

2 Sheets-Sheet 1



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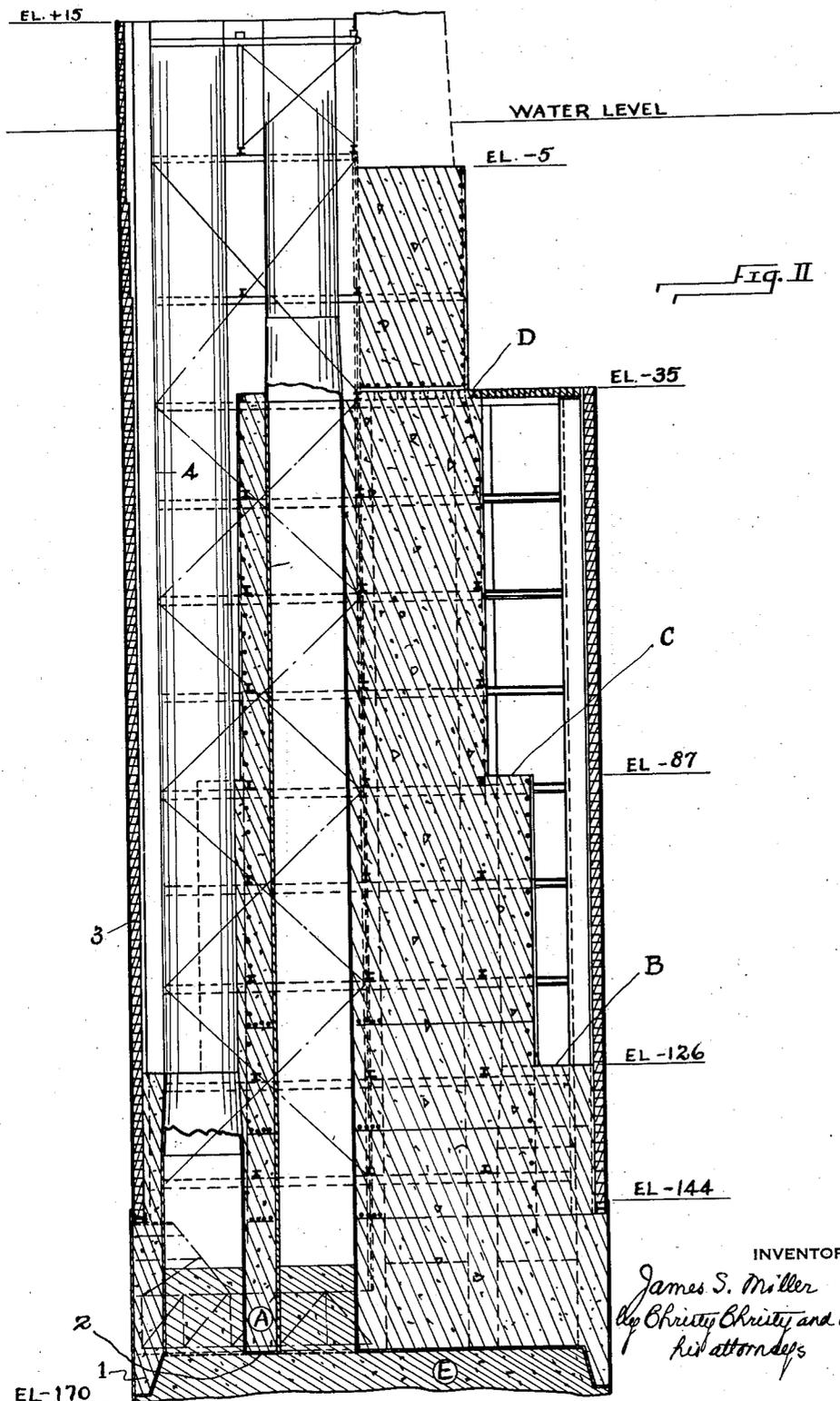
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SINKING OF CAISSONS AND THE BUILDING OF PIERS, ETC

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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SINKING OF CAISSONS AND THE BUILDING OF PIERS, ETC.

Application filed June 10, 1932. Serial No. 616,452.

This invention relates to the sinking of caissons and the building of pier-bases, and such like structures, and consists in improvements in caisson structure and in the method of sinking, in consequence of which the work may be carried to greater depth than otherwise would be possible and may go forward with greater safety and may be accomplished with saving of material.

The invention is illustrated in the accompanying drawings. Fig. I is a view in vertical section of the caisson as it is floated to place, before the sinking is begun; Fig. II is a view on the same plane of section of the caisson sunk to its ultimate position and of the pier-base, the building of which is accomplished in the sinking of the caisson; and Fig. III is a view in horizontal section, and on four planes of section, of the structure of Fig. II. The planes of section are indicated by the legends which the drawings bear.

In the particular case chosen for purposes of illustration, the caisson is to be sunk in the bed of a stream to a depth of 170 feet below the level of low water. The depth of the water at that point is from 60 to 90 feet; and, accordingly, the caisson is to be sunk from 80 to 110 feet in the bottom of the stream. The bottom is, to the depth of the work, composed wholly of a deposit of sand and silt.

The pneumatic method of excavation: the method, that is to say, of filling the bell of the caisson with compressed air, and in so doing driving water from the space within the bell and admitting workmen through the dredging wells to excavate the earth beneath the bell, is a method which is not practicable beyond the point at which a head of water greater than 110 to 120 feet obtains. In this instance, therefore, the sinking of the caisson must necessarily be completed by dredging; and, as a matter of fact, with the qualification presently to be described, will advantageously be performed wholly by dredging.

Referring first to Fig. I, the caisson includes a bell, a coffer wall, and dredging wells. The bell, in the form of an inverted pan of oblong shape, consists of a rim 1 and a floor 2. From the rim of the bell rise the

vertical and water-tight coffer walls 3, and, surrounding orifices in the floor of the bell, rise the dredging wells 4. The bell is formed of steel plate; its rim is reenforced with concrete filling a steel-braced shell. The coffer wall to the height of 26 feet from the rim of the bell is formed of steel plate; from that point upward it is formed of timber; and, throughout all its extent, all seams are properly caulked or otherwise made water-tight. The orifices in the floor of the bell and the dredging wells which rise from them are advantageously circular, and in this case are 10 to 12 feet in diameter. The walls of the well are made of steel plate and all seams are water-tight.

The caisson consisting of the parts described, and illustrated in Fig. I, is floated to position, and when brought to position is weighted by the building in of masonry (ordinarily in the form of concrete) on the upper face of the floor of the bell and between the dredging wells, at the point A, Fig. II. This built-in masonry becomes part of the substance of the pier-base itself, and the building-in progresses gradually as the caisson descends, until, ultimately, the pier-base is completed in situ.

The initial filling-in continues until the floating caisson is sunk and rests at the rim of the bell upon the bottom of the river. The coffer walls and the walls of the dredging wells are as a matter of practical convenience built up gradually as the caisson descends. Initially, they are of sufficient height to rise above the surface of the water when the caisson first is sunk and comes to rest on the bottom; and their gradual upward building maintains them always rising above the water-level, and always as they are extended they are made water-tight.

When the caisson has been brought to position and sunk, and rests upon the bottom of the stream, excavation begins. The river-bed material is cut from beneath the bell and removed through the dredging wells; and as the underlying material is so cut away and removed, the caisson with its growing burden of masonry (or concrete) descends by gravity.

The excavation and removal of the material will be accomplished in such manner as circumstances dictate. To a depth of 110 feet or more below water-level it is practicable to send laborers into the space beneath the bell (the space being filled with compressed air) and by their aid to dig away the river-bed material. Necessarily, at greater depths (and, if the nature of the bed material be suitable, it may at higher levels be found advantageous and economical so to do) the material is removed by dredging. In such case compressed air is not used; water rises in the dredging wells to common level with the stream outside of coffer wall 3, and dredging buckets are lowered and raised through the wells 4 to and from the surface of the excavation beneath the bell.

If, in the progress of work, and at a depth not too great to forbid, such an obstacle as the trunk of a tree be encountered, lying in the sedimentary material of the river bed, that dredging well or those dredging wells beneath which the tree trunk lies may be sealed; air may be pumped in, water expelled from beneath the bell, and workmen may be sent in to remove the obstruction. If such an obstacle be met at greater depth, removal will be effected by means such as are ordinarily adopted.

Consideration of Fig. III will make plain to those acquainted with the subject that the caisson here illustrated is provided with an extraordinarily large number of excavating wells, and that the arrangement of the wells is remarkable, in that they are widely extended in their location, and that as many as possible are symmetrically arranged as near as possible to the outer margins of the bell. Such an arrangement makes possible the enjoyment of the invention of Letters Patent, No. 1,706,246, granted on my application, March 19, 1929. The arrangement makes possible the enjoyment to the fullest extent of a feature of invention in method.

In the progress of such work it not infrequently happens that the deposit through which the caisson is being sunk is in different portions unequal in the resistance it offers to the descent of the caisson, and that in consequence tendencies develop to effect a departure of the caisson from its desired path of vertical descent. Having such a caisson as has been described, I have perceived that I may correct such tendencies by sealing one or more of the wells on the side of the caisson toward which the caisson tends to tip and pumping in air. In so doing the column of water within the well is displaced downwardly, and a buoyant tendency is at that point set up. Meanwhile, on the opposite side of the caisson, excavation may go forward, or the burden of masonry (or concrete) increased, until the tendency is over-

come and corrected. Thus it will be seen that in the practice of this feature of the invention stability may be increased and a danger of loss decreased.

In fuller explanation of tendencies of the descending caisson to depart from its desired vertical path, there may be a tendency of the caisson to tip—a tendency of one of the opposite sides to descend more rapidly than the other—; or there may be a tendency to drift laterally from the intended path of descent; or, again, such particular tendencies may be simultaneously manifest. And under any such situation, the possibility exists of sealing particular ones of the plurality of diversely situated wells and pumping in air, while continuing excavation through other particular wells. In such manner the descending caisson may be kept in its intended path.

My further invention also has to do with maintenance of stability, and the prevention of damage and loss consequent upon the tipping of the growing pier-base from its intended vertical position. In the erection of such pier-bases it is usual to form, in the manner described, the foundation block or footing as a column of uniform cross-section from the bottom upward. I have discovered that by stepping-in, by reducing the cross-section of the growing pier-base in a plurality of steps at successive points, it is possible, not merely to save material without loss of strength; but it is possible also to maintain at lower level the center of gravity of the growing structure, and by virtue of that fact to make it more stable and more effectively to prevent tipping. Such successive stepping-in will be noted, in Fig. II, at the points B (126 feet below water level), C (87 feet below water level), and D (35 feet below water level). It will be perceived that by such stepping-in, not only may material be saved, but that structure may be brought to relatively close approximation to the ideal in which with perfect economy of material the shape of maximum strength is attained.

Fig. II illustrates diagrammatically the finished structure. The body of masonry (or concrete), the building of which begins at A as described, progresses as the caisson descends, with stepping-in as described, until the whole body is built. Always, until the caisson approaches its ultimate position, the building of the masonry or concrete is carried on at a level considerably below water level, and this is so ordered that the center of gravity shall be low. The pier-base is then completed by the filling of the space within the bell with a block E of concrete (masonry is forbidden at a level below that practical for workmen in an atmosphere of compressed air), and this body of concrete may rise so far as is desirable in the dredging wells. These wells, however, will ordinarily be left open throughout all but the lower end of their

extent, for added weight which does not afford increase of strength or security is not desired.

I have indicated that, until the descending caisson approaches its ultimate position, the masonry work is done below water-level. And from what has gone before it will be understood that, in order to build masonry below water-level, it is necessary to maintain the height of the coffer wall above water-level. It remains to say that the point in the progress of the operation at which the upward extension of the coffer wall may be intermitted is a point that will vary according to the circumstances.

The invention has a characteristic of great value: the capacity, namely, consequent upon building below water-level, of maintaining the center of gravity at a low point. Under particular circumstances—in particular installations—that capacity, valuable initially, may become less valuable and may cease to have any practical value as the caisson descends. That is to say, the deposit into which the caisson is sunk may be of such firmness that, as sinking progresses, liability of the growing structure to overturn ceases to signify; and in such case, when the sinking has been carried to the point of security, the masonry may be built up to a level above water-level, and from that stage in the progress to the end the further upward extension of the coffer wall, being unnecessary, is dispensed with. The walls of the wells, however, will be maintained always above water-level.

I have described the invention as applied in the erection of a pier-base in a river bed. Manifestly there is an incidental and non-essential element in the circumstances; the essential characteristics lie in the erection of a structure of masonry (or concrete) in a bed of water-flushed earth.

I claim as my invention:

1. The method herein described of sinking a caisson in ground and to a depth below water-level exceeding the practicable limit of pneumatic excavation, which consists in bringing to position above its intended ultimate resting place a caisson including a bell with water-tight floor a marginal water-tight coffer wall and a plurality of wells with water-tight walls rising from orifices in its floor, one at least of such wells being situated at a point remote from the center line of the bell but within the compass of the said coffer wall, building masonry upon the upper face of the floor of the bell and excavating through the wells the underlying material, and in so doing causing the caisson to sink while water rises in the wells, maintaining the height of the walls of the wells always above water-level, and in the progress of sinking correcting tendencies of the caisson to depart from a path of vertical descent by

sealing and pumping air into a well remote from the center line of the bell and continuing the dredging through another of the wells.

2. The method herein described of sinking a caisson in ground and to a depth below water-level exceeding the practicable limit of pneumatic excavation, which consists in bringing to a position above its intended ultimate resting-place a caisson including a bell with water-tight floor, a marginal water-tight coffer wall and a plurality of dredging wells with water-tight walls rising from orifices in its floor situated adjacent opposite margins but within the compass of said coffer wall, building masonry upon the upper face of the floor of the bell and excavating through the dredging wells the underlying material, and in so doing causing the caisson to sink while water rises in the dredging wells, maintaining the height of the coffer wall and of the walls of the dredging wells always above water-level, and in the progress of sinking correcting tendencies of the caisson to tip by sealing and pumping air into a dredging well on the side which tends to sink lower.

3. The method herein described of establishing a pier foundation in ground below water-level which consists in bringing to position above its intended ultimate resting-place a caisson including a bell with water-tight floor marginal water-tight coffer wall and a plurality of dredging wells with water-tight walls arising from orifices in the floor of the bell adjacent opposite margins but within the compass of the said coffer wall, building masonry upon the upper face of said bell within the coffer wall and externally of the dredging wells, and dredging the underlying material through the dredging wells, thus causing the structure to sink, maintaining the coffer wall and the dredging-well walls at all times at a height exceeding water-level, and maintaining the sinking structure in vertical descent in spite of inequalities in resistance by confining in one dredging well a buoyant body of air while continuing through another well the excavating operation.

4. The method herein described of building a pier in ground below water-level and from a depth below water-level exceeding the practicable limit of pneumatic excavation, which consists in bringing to position above its intended ultimate resting-place a caisson including a bell with water-tight floor a marginal water-tight coffer wall and a plurality of dredging wells with water-tight walls rising from orifices in the floor of the bell situated adjacent opposite margins and within the compass of the coffer wall, building a body of masonry of upwardly diminishing cross-section upon the upper face of the floor of the bell

within the coffer wall and externally of the dredging wells and at a level below the water-level outside, and excavating through the dredging wells the underlying material, and
5 in so doing causing the structure to descend by gravity, and in such descent correcting tendencies to tip by confining a buoyant body of air within a well on the side of the structure that tends to sink faster than the other,
10 and finally filling the space beneath the bell with concrete and building the aforesaid body of masonry to its ultimate intended height.

5. A caisson adapted to be sunk in ground
15 below water-level including a bell with water-tight floor, a water-tight coffer wall rising marginally from the floor, and a plurality of water-tight dredging-well walls rising from orifices in the floor arranged adjacent
20 opposite margins of the bell and within the compass of the coffer wall, the space above the floor of the bell and within the coffer wall and external of the dredging wells being accessible for the building-in of masonry
25 as the caisson descends, the dredging wells severally adapted to stand open above and filled with columns of water to water-level or to receive and retain buoyant and water displacing volumes of compressed air.
30 In testimony whereof I have hereunto set my hand.

JAMES SMITH MILLER.

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