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J. S. MILLER

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METHOD OF BUILDING PIERS

Filed March 3, 1928

Fig. I.

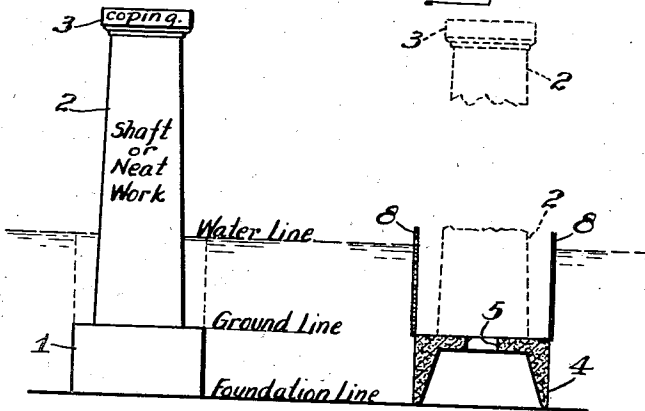


Fig. II.



Fig. III.

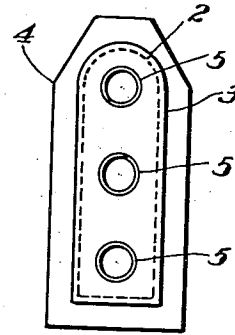


Fig. IV.

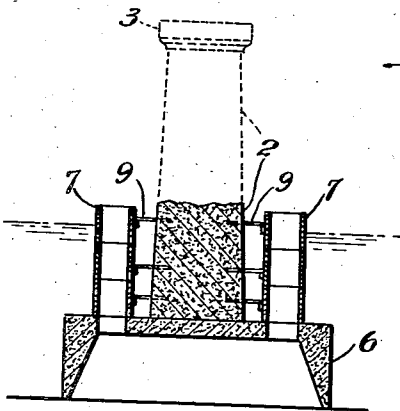


Fig. V.

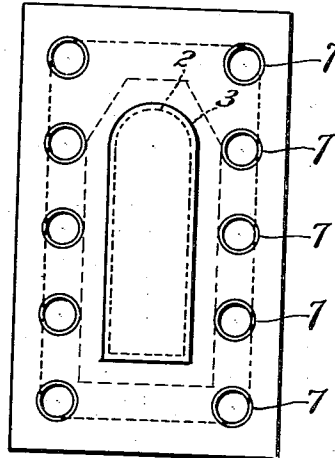


Fig. VII.

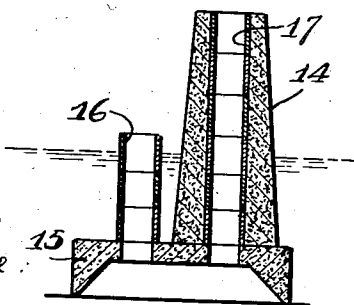
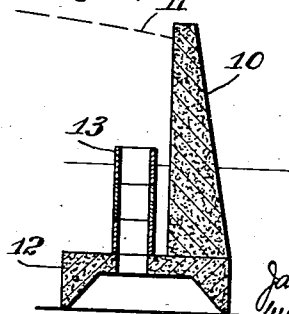


Fig. VI.



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METHOD OF BUILDING PIERS.

Application filed March 3, 1928. Serial No. 258,324.

My invention relates to the building of the shaft where it is superposed on the foundation or footing. 55
piers, abutments, dock walls, dams, retaining walls, and such like structures, whose foundations are sunk into the earth, it may be in the bed of a stream or other body of water, it may be in water-soaked or in dry ground. The invention consists in a method of building, such as to afford a better structure, more accurately located, built with better economy. 60

The invention is illustrated in the accompanying drawings. Fig. I is a view in end elevation of a bridge pier of familiar form and structure. Fig. II is a diagrammatic view, illustrating in vertical section a method commonly followed in erecting a pier such as that shown in Fig. I. Fig. III is a plan view from above of the diagrammatic showing of Fig. II. Figs. IV and V are views corresponding to Figs. II and III and illustrating those modifications in structure and in method, in which and in the practice of which my invention is found. Figs. VI and VII are views corresponding to Fig. IV and illustrating the invention in its wider applicability. 65

Confining attention, first, to the building of piers, and referring to Fig. I, a bridge pier of typical form is shown. It is an integral structure, which may be understood to be built of masonry, and in modern practice, wholly or in part of concrete. It includes a foundation or footing, 1, a shaft, or, as it is often called, the "neat work", 2, and this is surmounted by a coping, 3. Understanding that such piers are erected on ground which may be flushed with water, and where a foundation upon rock may be unattainable, it will be perceived that the footing 1 constitutes a wide extending enlargement upon the lower end of shaft 2, and by virtue of such greater extent affords firmer standing for the pier. The footing is commonly formed by sinking a crib or caisson to the desired or necessary depth, beneath water if need be, and into the earth, and then filling with masonry or with concrete, as the case may be, the space excavated beneath the caisson. 70

In the design of piers the principal dimensions are generally controlled by two factors, first, the character of the foundation bed which determines the bottom area of the foundation or footing, and, second, the superposed load which determines the base area of 75

Referring to Figs. II and III, the caisson 4 used in building a pier is, essentially, a sharp-rimmed bell, sunk edge first into the ground. A tube or tubes 5, commonly called dredging wells, enter the caisson from above, and through the dredging wells dredging apparatus may be introduced; through them workmen have access to the interior; through them the excavated material is removed; through them air enters to fill the excavated space. If necessary, air is introduced and maintained under pressure within the caisson, to afford conditions under which workmen may carry on excavating operations. 80
Through the dredging wells eventually the masonry or other material, ordinarily concrete, is introduced, to fill the space excavated beneath the caisson. And when this is done the caisson with its filling together constitute the footing of the pier. Externally the caisson will ordinarily be square cornered, as the drawings show, for it will be perceived that the caisson constitutes the exterior portion of the ultimately completed footing. 85
The caisson may be built of materials of one sort or another, but in modern practice it ordinarily is a block of concrete formed upon a frame of iron. Its rim is wedge shaped in vertical section, the outer face vertical, and the lower cutting edge is shod with steel. In the typical case illustrated in Figs. II and III the dredging wells rise, as will be perceived, vertically through the space which eventually is occupied by the shaft 2. 90

Generally, in the practice which has hitherto been followed, the offsets where the foundation ends and the shaft begins are not large and in no case known to the inventor are they of sufficient width to permit of the application of so called dredging wells used in caisson construction outside of the shaft or neat work, nor is any case known where dredging wells have been used outside the neat lines of shaft as an aid or device for sinking a crib or caisson nor for any other purpose. See Fig. I for illustration of common type of pier. 95

The types of caissons now in general use are equipped with a limited number of dredging wells located within the outline of the neat work, and generally at or about the center line or longitudinal axis of the caisson and 100

of the shaft to be constructed thereon. There are cases where more than one line of dredging wells have been used; in all such cases, however, they have been located inside the outline of the neat work of the shaft.

Under conditions which may arise during the lowering or sinking of caissons, due to location, or character of earth encountered, or current of stream, or all of these, it is found difficult to maintain the longitudinal axis of the caisson in its exact location as to alignment laterally and longitudinally, and further in many cases it is difficult to hold or maintain the caisson during the lowering or sinking to exact level transversely and longitudinally. It is because of the fact that some tolerance must be afforded and allowance made for the placement of the footing, and because its actual position may but roughly approximate the ideal and desired position, that the shaft which is erected upon the footing and which rises in accurate position, is by way of distinction termed the "neat work".

The object of my invention is to provide a new and unique method of construction and of sinking or placing caissons, such as will in large measure avoid and overcome the difficulties above enumerated, and will reduce the tendency to tipping in landing a caisson in place. A further object is to render unnecessary, in many cases, the use of detachable coffer-dams, so called, which are commonly used in the present method of constructing and sinking caissons. My invention simplifies the work of construction and placing of caissons and foundations and thereby reduces the cost of constructing such work. The use of my invention will reduce the time required for construction, an important factor where high water or floods may be encountered. Incidentally to the practice of my invention, the bearing load of the finished structure on underlying soil or foundation is decreased without materially increasing the cost of construction.

My invention is found in an enlargement of the caisson, in employing (in the case of the erection of a pier) a caisson for a shaft of given dimensions which shall be greater in lateral extent than otherwise would be required, and in the arrangement of the dredging well—or dredging wells, for ordinarily there will be a plurality of these wells, symmetrically arranged—outside of the space which eventually the shaft will occupy. In Fig. IV such a widened caisson, widened to effect the ends and purposes I have in mind, is indicated at 6. This widening and enlarging of the caisson will be more fully apparent on comparing Figs. III and V, and in Fig. V the outline of the caisson of Fig. III is superposed in dotted lines, merely to indicate more fully and precisely the change and the effect of the change in dimensions. In consequence of such lateral extension of the

caisson, the dredging well or wells 7, instead of being situated within the space in which eventually the shaft 2 rises, are situated externally of that space. And these dredging wells are, as will be perceived, advantageously arranged in symmetrical grouping with respect to the longitudinal and transverse vertical axial planes of the structure.

Because of the enlargement of the caisson in its lateral extent, its weight is more widely distributed, the pressure per unit of area is less, the pressures at symmetrically opposite points may be more fully equalized, the caisson may be sunk with better accuracy and with less tipping, and may be brought to its ultimate position with greater accuracy. In consequence of improvement in accuracy of placement, it is no longer necessary to delay the erection of the shaft until after the footing has been completed, but (in the case of the building of a pier in a river bed, for instance) the shaft may rise as the caisson sinks, and the building of the shaft may always be carried on above the surface of the water. In the usual practice, it being practically necessary to delay the erection of the shaft until the caisson has come to its ultimate position and until the footing has been completed, it is requisite (when making erection in water) to build a coffer-dam, rising from the caisson to a height greater than the ultimate depth to which the caisson is sunk. The position of such a coffer-dam is in Fig. II indicated at 8. Within this coffer-dam, after the footing has been completed, the shaft 2 ultimately is built. Since I may proceed with shaft building while the caisson still is in course of descent, and so may do the shaft building always above water level, it is manifest that no coffer-dam such as that described, is needed. In building a pier in the old manner, if by chance circumstances justify the progressive erection of the shaft as the caisson descends it still is necessary to leave a dredging well open through the shaft, to be filled eventually, after the caisson has reached its position and the excavation beneath has been filled. But in following the procedure in which my invention is found, since the dredging wells are external to the shaft space, the shaft itself which is progressively built, may be built without any well space, and solid if desired, and so shaft building is simplified and improved.

The dredging wells which I provide externally of the shaft space, may conveniently be formed of superposed sections of suitable size and of suitable material. Conveniently they may be cylindrical shells of metal, say seven feet in diameter, built one upon another as the sinking of the caisson progresses, so that always the mouth of the dredging well shall be above but not greatly above the water level. Such superposed sections are indicated in Fig. IV, and it will be perceived

that the uppermost rise above the water line. These successively built up sections of the dredging wells may be braced individually as they are built to place, and in Fig. IV I have indicated braces 9, securing them to the growing shaft 2.

Given such a caisson so dimensionally related to the shaft of the pier to be built, and so equipped with dredging wells, the operation is in its general character the usual one. Because the caisson may be more precisely controlled and its position predetermined with substantial accuracy, the work of the building of the shaft may begin before the caisson comes to its ultimate depth, and may progress as the descent of the caisson continues, and may from beginning to end be carried on above water level, and so the necessity of resorting to coffer-dam structure in order to build the shaft, may be overcome, and the coffer-dam dispensed with. The sectional shells which form the walls of the dredging wells may be built one upon another gradually as the sinking of the caisson progresses. When the caisson has come to its ultimate position (and with a precision of place not hitherto attainable), the excavated space beneath may be filled in usual manner, to the bases of the dredging wells. The sectional shells which constitute the walls of the wells may then be taken away, and may be used again, although in particular situations it may be found advantageous to abandon them or part of them, as false work not worth salvage. The building of the pier progresses from this point forward in usual manner.

The invention is applicable, whatever be the shape of the pier,—elliptical, circular, octagonal, polygonal, dumb bell shaped, parallel sided, with square, rounded, or pointed ends, or otherwise shaped. Figs. III and V of the drawings show a pier of elongate plan with opposite parallel sides, rounded at the up-stream end, and square at the down-stream end, but it will be understood that this particular shape is merely the shape found in the instance chosen for illustration, by way of example, and is accidental merely to the disclosure of the invention.

The invention is not limited in its applicability to the erection of bridge piers. Fig. VI illustrates its application in the erection of a retaining wall. The retaining wall 10 is shown in cross-section, and will be understood to be of indefinite length. It may be built in sections. The caisson 12 which is sunk in the manner already described, is equipped with a dredging well or dredging wells, of which one is shown at 13, and shown to be external of the space occupied by the neat work of the wall, to which the numeral 10 is immediately applied. As in the case of the pier, the neat work 10 may be erected as the caisson sinks, or in particular instances it may be erected after the caisson has come

to rest and the footing has been completed. The dredging wells are a temporary provision; they ordinarily will have no continuing existence in the finished job. Filling material may eventually rest against the wall, as indicated by the dotted line 11, and the widening of the caisson and the provision of the dredging well or wells are conveniently arranged on that side of the wall against which the fill 11 eventually is to rest.

Fig. VII similarly shows a dam structure whose footing is shaped and sunk in accordance with my invention. The neat work of the dam is indicated at 14, the caisson which is employed in the sinking and forming of the footing of the dam is indicated at 15, and the position of a dredging well external to the space eventually occupied by the neat work, is indicated at 16.

Fig. VII serves additionally to indicate that, while the invention is found in the provision of a dredging well or wells external to the space occupied by the neat work, it does not forbid the provision of and the use of another dredging well or other dredging wells arranged according to the hitherto existing practice, within the neat-work space. In Fig. VII a dredging well so situated is indicated at 17, and it will be understood that generally in the practice of my invention, a dredging well so interiorly situated may if for any reason it be found desirable, be employed in association with and by way of supplement to, or for cooperative use with the exteriorly arranged well of my invention.

Similarly as the invention is employed in erecting piers, retaining walls, and dams, it may be employed in erecting abutments, dock walls, guide walls for locks, structures inclusive of a plurality of walls with filled or unfilled space between, and masonry structures generally, including of course such as are built wholly or partially of concrete. The ground where erection is made may be water soaked or dry, submerged or above water level.

The caissons employed may be formed of wood, steel, concrete, or reenforced concrete, or of a combination of these materials. In manner of sinking the caisson may be an "open" caisson (using a phrase current in the industry), or in contra-distinction, it may be a "pneumatic caisson", or it may be a caisson in which the open and pneumatic systems are successively employed. The dredging wells may be of any suitable shape and size, and may be formed of any suitable material, of wood, metal, concrete, reenforced concrete, or of other material. Though advantageously erected progressively and section upon section, they need not be sectional, and if sectional they may be made of sections of any convenient length.

In consequence of the use of my invention, I have more complete control in sinking or

lowering cribs or caissons, and consequently accomplish a more exact placement of the footing of the ultimate structure. Tendencies to tipping are reduced, the pressure upon the foundation bed per unit of area is less, and the gain is economically effected. Because I am able to begin the erection of the neat work while the caisson is still in course of sinking, I may gain added weight, and effect the sinking of the caisson with greater speed. The avoidance of the necessity of using coffer-dams, a matter already mentioned, is manifestly advantageous. I can sink a caisson to a given depth using the open dredging method to a maximum extent and with a minimum resort to the pneumatic method,

and can safely sink a caisson to a greater depth than is possible under the practice hitherto available.

In the ensuing claim the term masonry is used in larger sense, inclusive of concrete and such like materials applied in bulk and shaped to place.

I claim as my invention:

The method herein described of building a masonry structure which consists in excavating material from beneath a caisson and removing the excavated material externally of the lines of the neat work of the structure.

In testimony whereof I have hereunto set my hand.

JAMES SMITH MILLER.