May 9, 1933. D. E. MORAN 1,907,854

SINKING FOUNDATION

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Fig. 1.

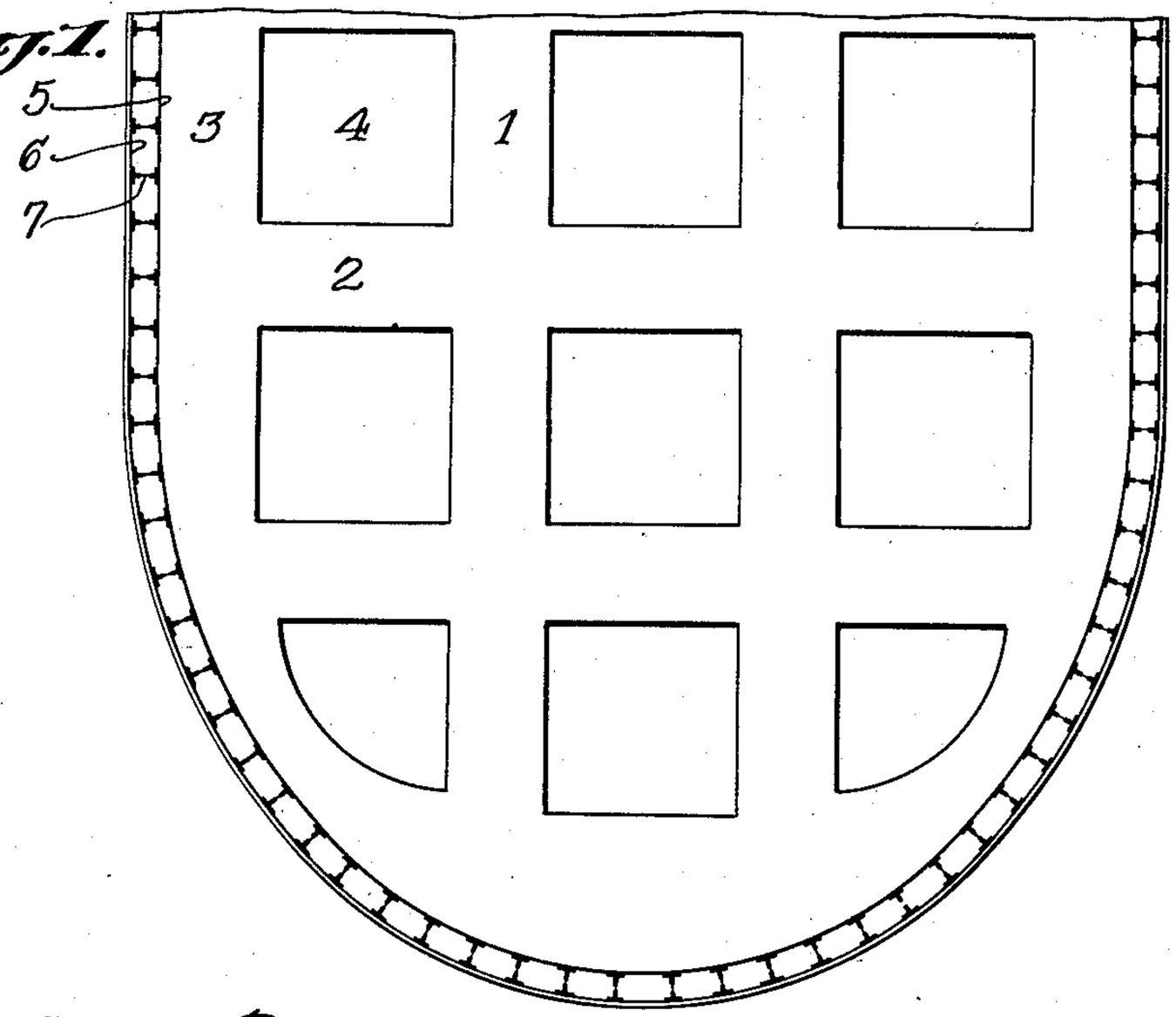
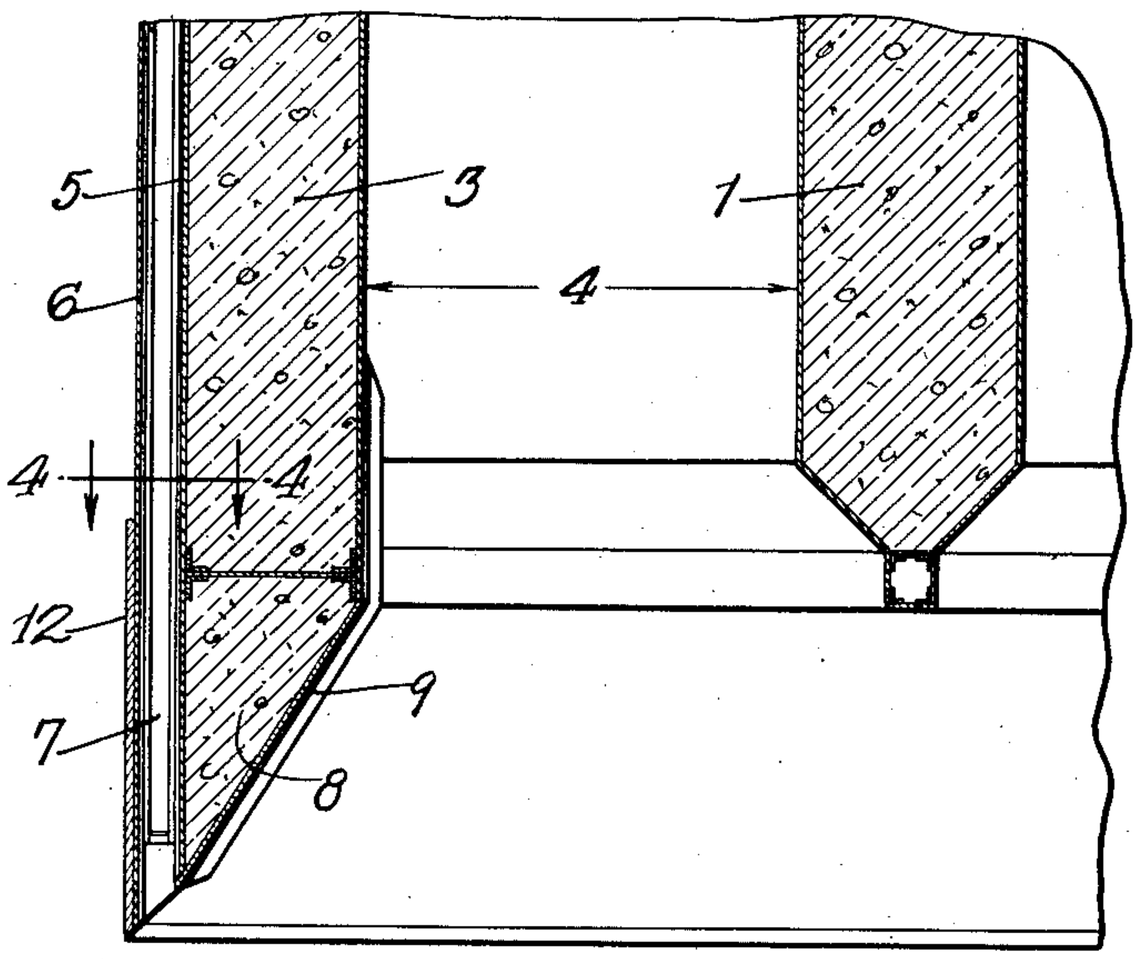


Fig. 2.



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SINKING FOUNDATION

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Fig. 3.

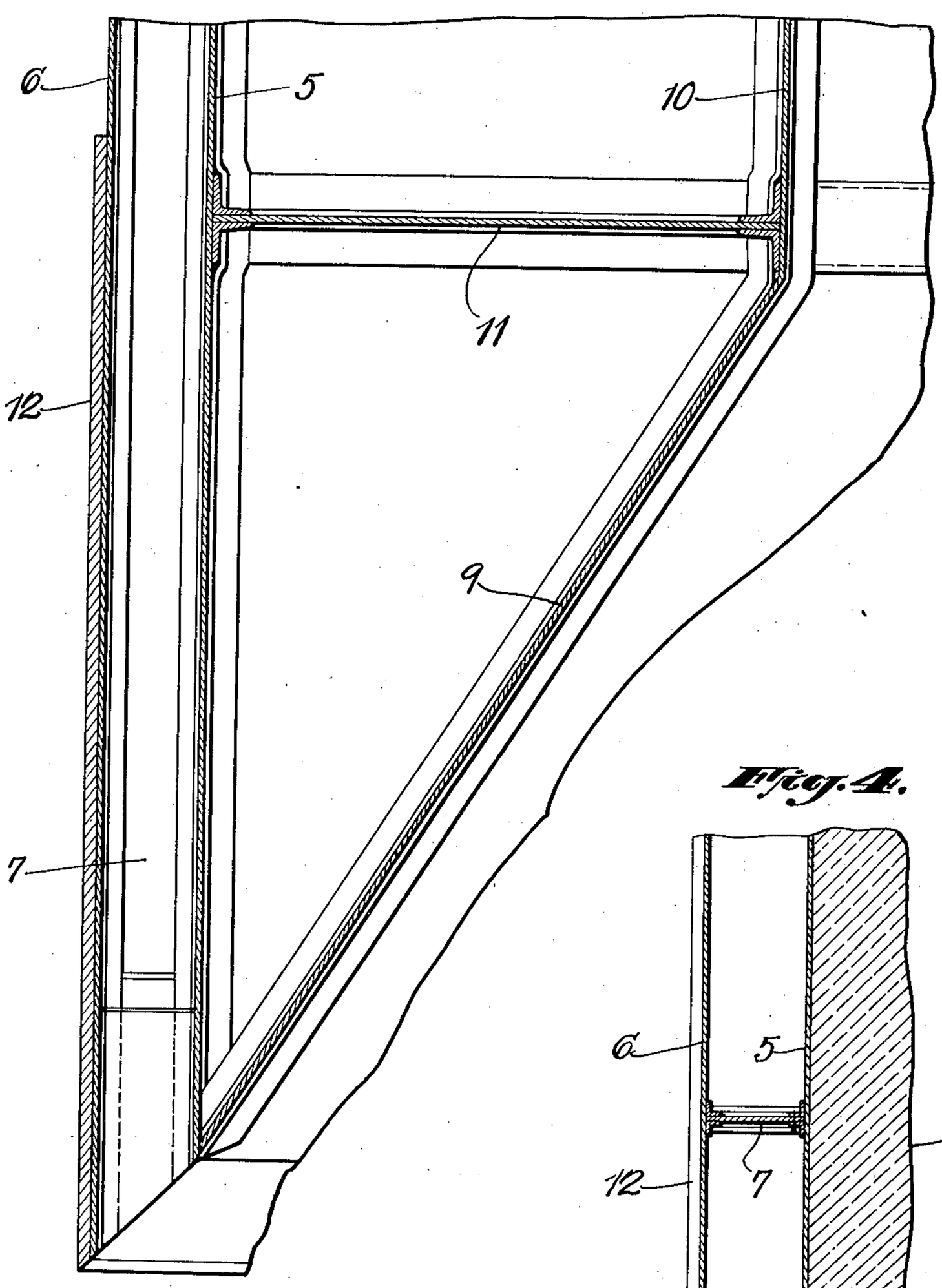

Fig. 4.

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SINKING FOUNDATION

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Fig. 5.

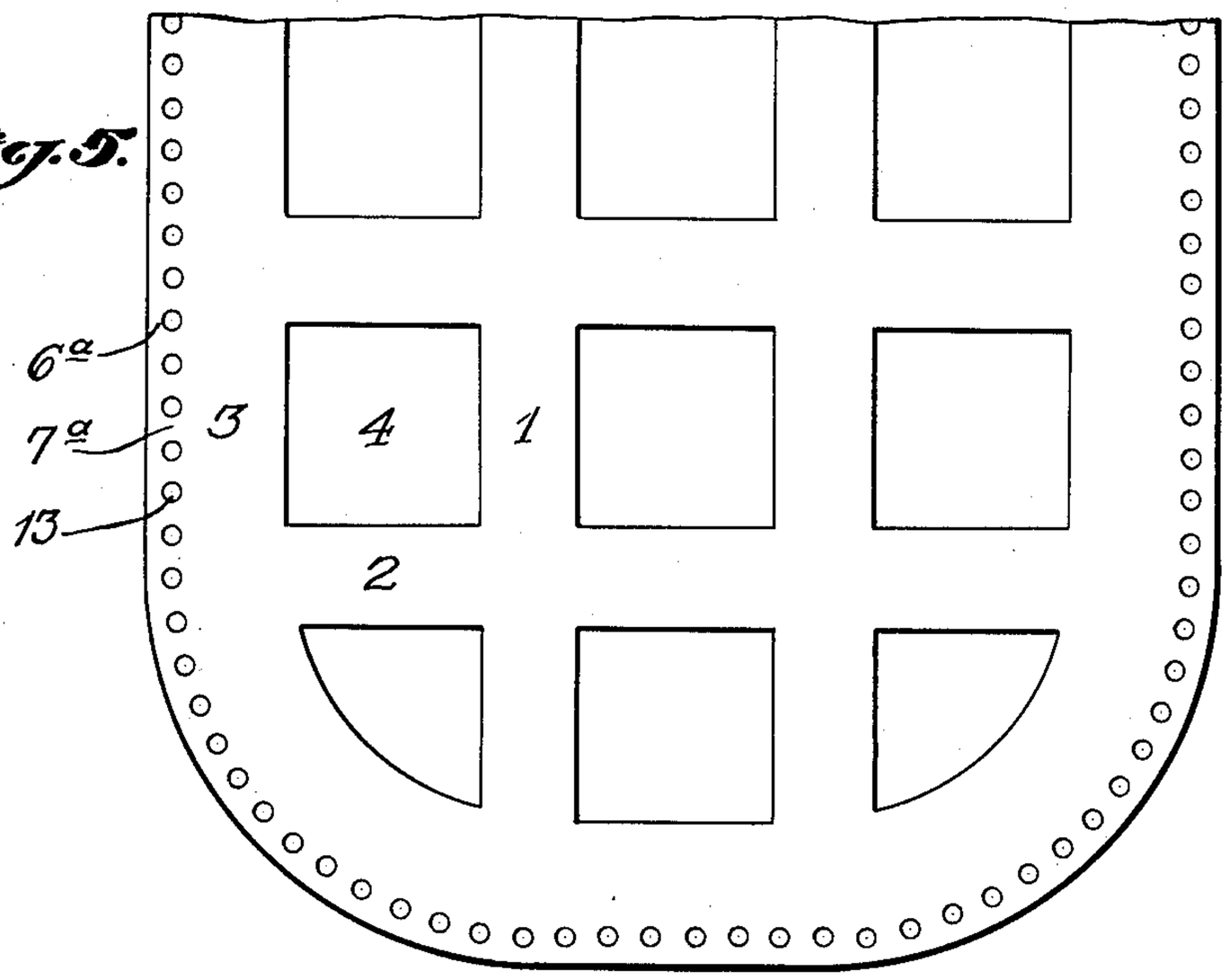
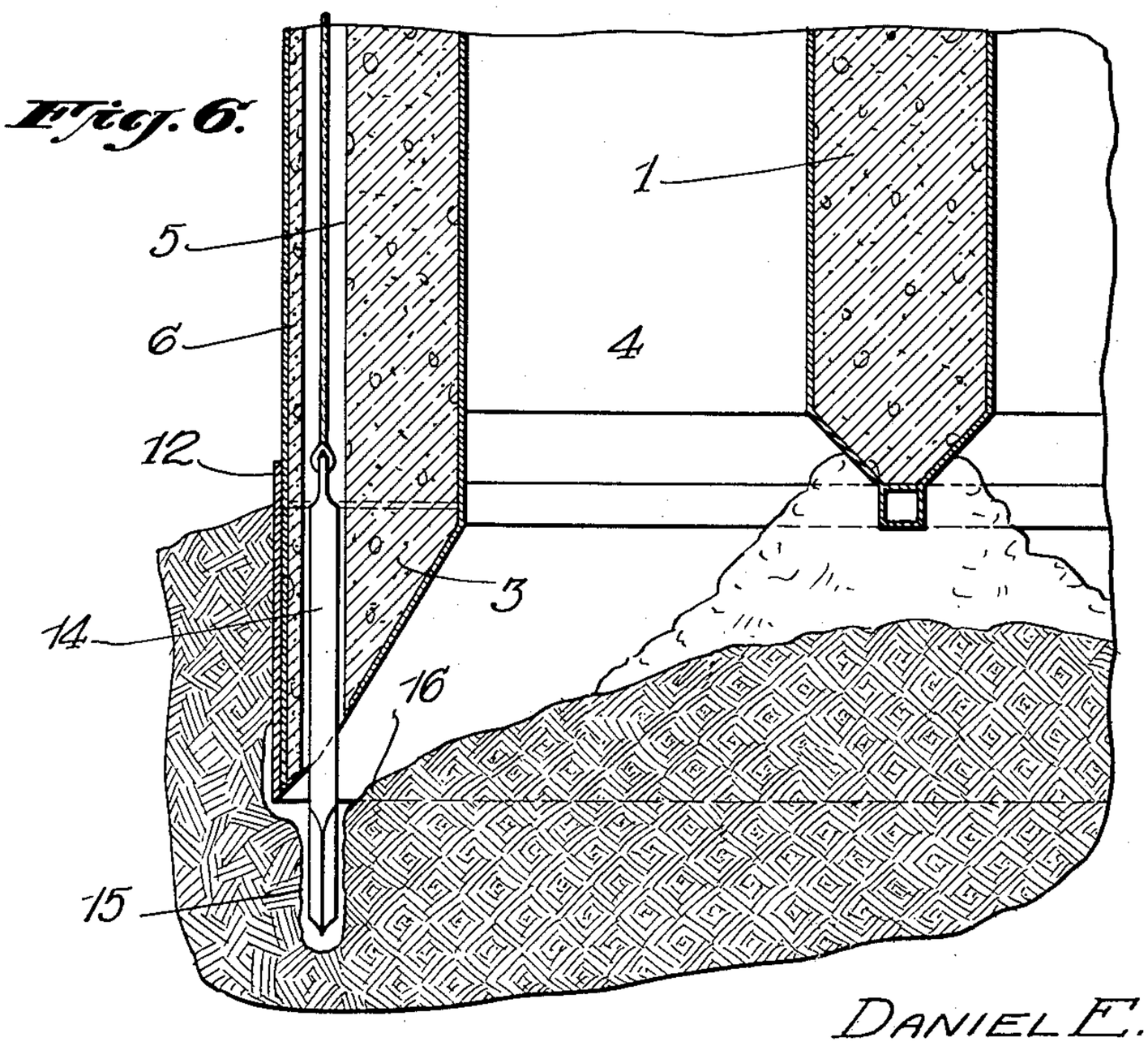


Fig. 6.



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SINKING FOUNDATION

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Fig. 7.

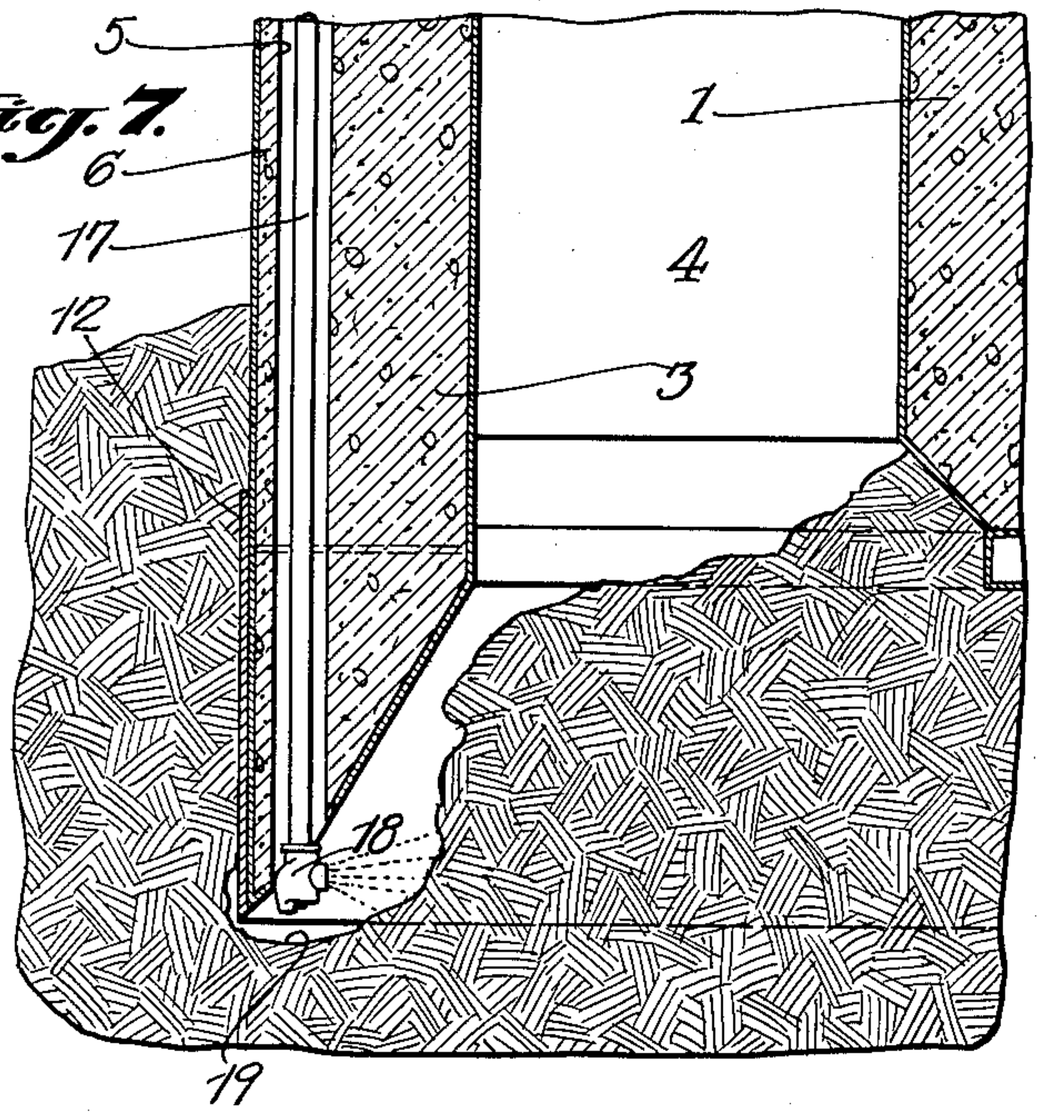


Fig. 9.

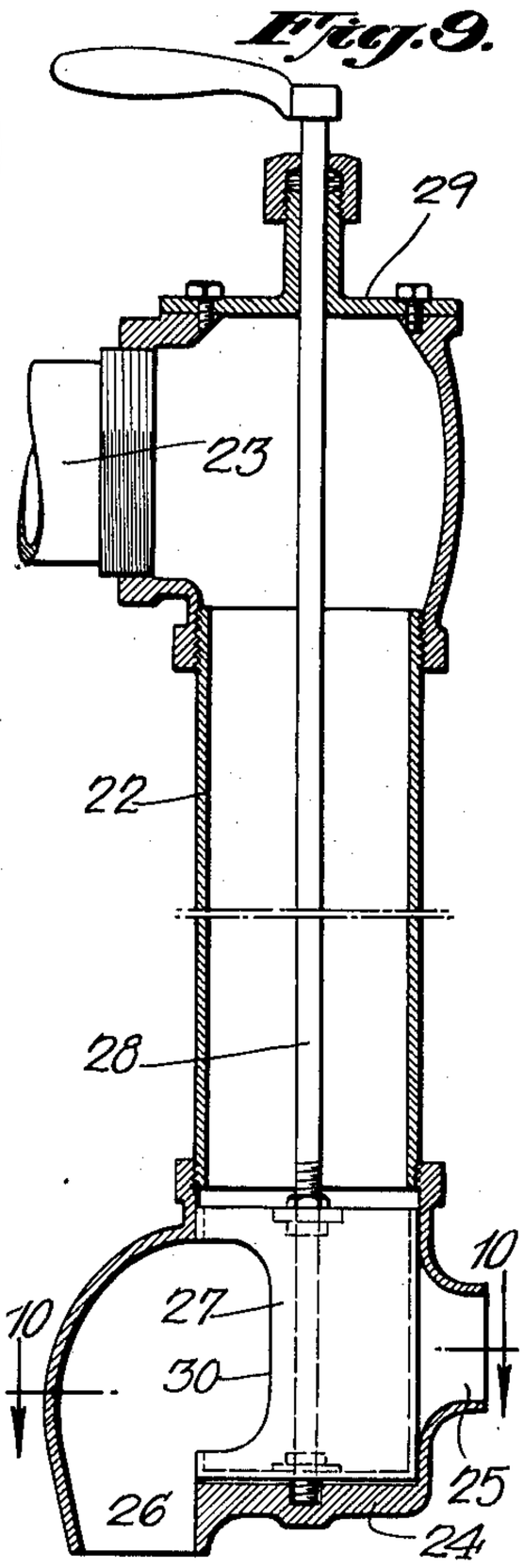


Fig. 8.

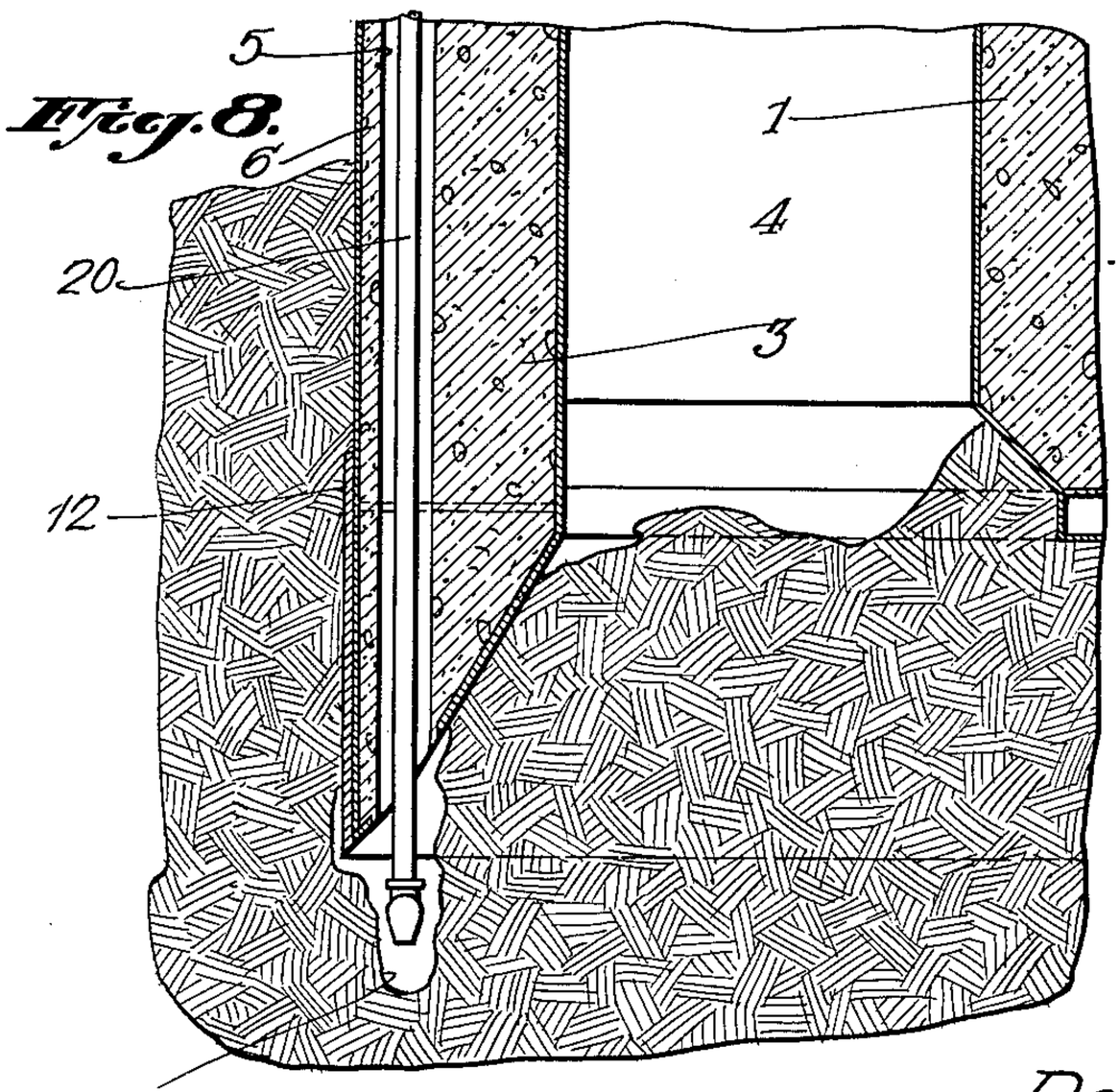
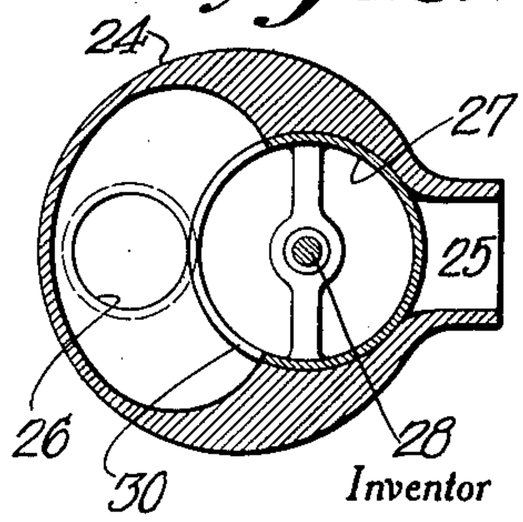


Fig. 10.



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Patented May 9, 1933 1,907,854

UNITED STATES PATENT OFFICE

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SINKING FOUNDATION

Application filed July 2, 1931. Serial No. 548,335.

In the so called dredging method, piers, foundations and other constructions are sunk through sand, clay and other materials to a firmer material, suitable for founding the structure. In the case for instance of a bridge pier, the lower portion of the structure is generally constructed as a floating structure which is built up until it grounds on the bottom of the river or other body of water, or if the site is above water level the structure may be built in place to a convenient height. The structure is then sunk by removing the material below the structure, by dredging through open wells, which may be described as being vertical open cells extending from top to bottom of the structure; these cells being made of a cross section sufficient to permit the operation of the dredging apparatus. The exterior walls of the structure being sunk serve to prevent the unexcavated material surrounding the structure from caving in.

It is found in practice that while it is practicable to remove the material directly under the open wells, it is frequently difficult to remove the material under the structural walls surrounding the open wells. It is found in practice that it is convenient to incorporate cells other than the dredging wells in the structure. These cells having closed bottoms and being occupied by air serve as floating chambers; in other words, the structure is made cellular for lightness. Subsequently the floating cells may or may not be filled with concrete.

My invention relates to means for removing or facilitating the removal of the natural material directly below the walls of the structure, and especially the external walls. In certain designs, in order to reduce the amount of material under these external walls, the external walls have been reduced in thickness to the minimum thickness consistent with strength. The lower end of the walls has been formed into a wedge so as to facilitate the motion of the material from the space below the wall inward, to the space below the dredging well. Notwithstanding these efforts, it still remains a difficult and sometimes an impracticable task to remove the material under the external walls. During the process of sinking the structure, it is in general desirable to have the structure heavy so as to cause it to sink. This requirement is met by making the walls thick and the dredging wells small, but this in turn increases the difficulty of removing the material under the thick walls. My invention is to provide means for moving this material even if the walls be thick.

In the ordinary dredging operation the excavation by dredge may extend down to or below the level of the exterior walls, leaving a wall of natural material exposed on the side toward the dredging well, but continuous with the material outside of the wall. The cohesion of the material immediately below the exterior wall to the material outside of the wall contributes to the strengh of this natural material and to its resistance to motion toward the dredging well. My invention provides means for destroying this cohesion, and provides means for producing motion of the natural material under the exterior wall into the space below the dredging well.

It has been customary to attempt to remove this material by the use of jets and cutting tools operated from the surface through the water contained in the dredging well and controlled through the instrumentality of long connecting pipes or structural parts extending from the surface to the bottom of the strucure.

It is evident that such devices are difficult to control when the depth of the water is great, sometimes considerably over 100 feet in depth. These appliances must be lowered through the water and held in correct position to effectively work on the material to be removed; for which purpose, they must be movable laterally under the wall. Moreover, the action

of all such appliances is outward action, contrary to the direction in which it is desired to move the material.

In other cases attempts have been made to use jets or other appliances working from the surface and extending downward on the outside face of the wall to the bottom of the wall. This necessitates traversing the natural material outside of the wall. It has been found extremely difficult to use such devices in practice; and especially so, because in the operation of sinking the device through the natural material there is no means of controlling its position accurately so that it will operate on the material below the wall and in the direction toward the well.

In other cases progress has been made by the use of hydraulic jets or jets of compressed air, acting from the surface through pipes contained in the structure, which pipes had fixed orifices directing the jet at certain points in certain definite directions toward the material to be removed. In order to make this use of the jets effective it is necessary to use an enormous number of jets and jet pipes and the method is only effective where the material yields to the jet, and only in the direction in which the jet acts.

In my invention I provide a series of vertical openings extending from the top to the bottom of the structure immediately inside the outer of the walls of the structure. I connect the outer skin or surface of the structure with the main structure by constructing vertical walls at frequent intervals. These walls may be thin so that the vertical openings are practically continuous following the periphery of the outer wall or the vertical openings may be formed in the body of the wall and interspaced as desired. They serve to permit the use, in any opening, of a jet pipe, which can be lowered through the opening to the bottom of the structure and which may be used to excavate the material immediately below the opening to any required depth. For this purpose the jet may be directed downward and the excavated material may be carried upward through the opening to the surface, as is ordinarily done in the case of sinking pipes by the hydraulic jet. The excavated material under these conditions may in some cases move into the dredging well. If desired the jet may have an opening directing a portion of the jet downward, and a second opening directing a portion or all of the jet laterally. Means may be employed above water level to direct the lateral jet in any direction and at any level. Also, means may be employed to close either of said openings automatically from the surface and so concentrate the jet action in any direction desired. In the use of a jet through the vertical opening which I provide, the lateral position of the jet relative to the wall is fixed by the opening itself, so that its action is concentrated directly under the wall. This avoids the difficulty of locating jets inside the well or outside the pier. But the jet may be rotated so as to act in any desired direction, and raised or lowered so as to act at any desired level.

In case the material beneath the wall does not yield to a jet, I may use a cutting chisel operated from the surface through the opening. Such a cutting chisel known as the Lobnitz chisel will effectively cut a trench in rock or other solid material to any required depth directly below the several openings, or I may use any drilling device, operating same from the surface through said openings to permit the placing of explosives in the material below the wall and at a safe distance below the bottom of the wall so that said material may be shattered, loosened and removed conveniently toward the well. Or I may use these openings to permit the placement, along a line adjacent to the exterior face of the outer wall, of a downward extension of the structure itself below the bottom of the wall. As a special case of the latter use, I may use the opening to introduce anchoring spuds consisting of long, strong structural members, such as wooden piles, wooden timbers, or steel rolled sections, which may be dropped from the surface through the opening and driven or otherwise placed in the material under the walls and in line with the outer face of said wall. Such spuds are effective means for connecting a floating construction such as the caisson structure with the bottom of the river for the purpose of anchoring or positioning the caisson at its desired location.

In certain cases it may be desirable to extend the excavation to a greater depth than it is possible, or desirable, to sink the caisson. In such case I may use the openings to drive from the surface structural members forming a practically continuous downward extension of the structure in line with the exterior face of the structure. In various patents there is described a method of driving such a continuous wall close to the external face of the structure. The said wall was placed outside of the caisson and was driven by means necessarily employed outside of the structure. Consequently this work had to be done through the material exterior to the caisson and without means for insuring the position or direction of the work.

The accompanying drawings illustrate an embodiment of the invention more or less diagrammatically.

Fig. 1 is a plan of part of a pier.

Fig. 2 is a vertical section of a portion of the lower edge thereof.

Fig. 3 is a similar view on a larger scale.

Fig. 4 is a horizontal section on the line 4—4, Fig. 2.

Fig. 5 is a partial plan of a modification.

Figs. 6, 7 and 8 are vertical sections illustrating different methods.

Figs. 9 and 10 are vertical and horizontal sections of a jet pipe.

Referring to the plan, Fig 1, the pier or caisson is built of concrete with longitudinal braces 1, transverse braces 2 and an outer wall 3, leaving dredging wells 4 through which the earth, rock or other material is removed. The main wall 3 is enclosed within an inner shell 5 of steel. Surrounding the pier and spaced therefrom is an outer steel wall 6 connected to the inner wall at intervals by braces 7. In a large pier, for example, the main wall 3 may be 5 or 6 feet thick, the space between the shells 4 and 5 may be about 1 foot wide and the space between the connectors or braces 7 may be 2 or 3 feet; these connectors being steel plates or shapes so that they occupy very little space in thickness and leave a peripheral space around the outside of the pier which is practically continuous in the sense that it permits access to the material below the pier along a continuous line around the outside. These openings extend from an accessible top level clear to the bottom to permit the introduction and manipulation of the various tools above referred to for separating the earth immediately below the wall from the surrounding earth and to permit the introduction and control of structural members to form extensions beyond the lower edge of the pier wall.

Figs. 2 and 3 show the lower edge portion 8 of the wall with its inner face flared outward and faced with a plate 9 shown best in Fig. 3 where the concrete is omitted in order to show the steel work more fully. The dredging well 4 is lined with sheet steel 10 which is connected to the shell 5 by cross girders 11 at intervals; forming a vertical space between the inner shell 5 on one side and the plates 9 and 10 on the other side, which is filled with concrete.

Outside of the outer shell 6 there is imposed a vertical cutting plate 12 extending substantially throughout the height of the beveled portion of the wall and downward beyond the shell 6 to protect the lower edge of the latter.

The space between the inner and outer shells 5 and 6 surrounding the wall of the pier constitutes a novel provision for controlling the direction and use of a multiplicity of tools and structures of various kinds; without the use of one tool precluding the substitution of another tool as has generally been the case with previous structures. The outer shell has little or no practical value as a contribution to the strength of the pier, serving chiefly as a restraining means for guiding tools or supplementary structures along vertical lines coinciding with the outer face of the pier itself.

The openings themselves between the shells 5 and 6 may be used as water or air conduits. The outer shell 6 may have openings through it at intervals. Jets of air or water may be forced through these openings to lubricate the outer face of the shell and lessen its adhesion to the surrounding earth. The outer shell 6, and also the inner shell 5, need not be solid plates. Openings may be made in them to lighten the structure. In fact it is only necessary that there be enough structural metal to form guiding and holding means for the instruments and purposes above stated.

Instead of the metal structure around the pier shown in Figs. 1 to 4, the outer shell may be of concrete integral with that of the body of the pier. Fig. 5 shows such a construction. The main wall 3 is surrounded by an outer wall 6^a connected integrally to the main wall by connectors 7^a which are integral webs of concrete between the closely spaced openings 13. The openings extend clear to the bottom as explained in connection with Fig. 1 to permit the introduction and control of tools or structural members.

Fig. 6 illustrates the use of chisel bars 14 to drill a line of holes 15 in the rocky bottom 16. In some materials these drills will form practically an annular excavation. In harder rock there will be a series of holes which can be converted into an annular excavation by withdrawing the drills and introducing explosives.

Fig. 7 shows the use of a pipe 17 at the lower end of which is a lateral jet nozzle 18 which forms a sort of annular trough 19 around the edge of the pier.

Fig. 8 shows the use in an analogous way of a jet pipe 20 with its orifice directed downward so as to cut an annular trench 21.

The jet pipe may be arranged as in Figs. 9 and 10, to direct the air or water jet either downward or laterally (inward or outward) as may be desirable under special circumstances. The pipe 22 is supplied from the hose 23 and has at its lower end a sort of valve casing 24 with a lateral outlet 25 and a vertical outlet 26. An annular valve 27 is mounted in a casing to rotate about a vertical axis and is carried by a stem 28 which extends through a cap 29 on the top of the pipe and carries a handle at its outer end. The valve is shown set to direct the jet downward. By turning the handle 180°, it will cause the jet to issue laterally. In the intermediate position, the opening 30 will be in communication with both branches of the casing so as to direct part of the water laterally and part of it downward.

Various modification may be made by those skilled in the art without departure from the invention as defined in the following claims.

What I claim is:—

1. A hollow foundation pier having a multiplicity of vertical bottomless passages

formed in an integral part of said pier at the outer surface thereof forming a practically continuous annular opening around and adjacent to the exterior face of the pier, permitting the use of selective and adjustable devices for separating the earth below the pier wall from the surrounding earth, the walls of said openings forming means for controlling the position and direction of action of said devices.

2. A concrete foundation pier having around its body portion a shell of concrete integral with the body and connected thereto by comparatively thin webs leaving a number of vertical bottomless openings forming practically continuous openings around and adjacent to the exterior face of the pier permitting the use of selective and adjustable devices for separating the earth below the pier wall from the surrounding earth, the walls of said openings forming means for controlling the position and direction of said devices.

3. The foundation pier of claim 1 in combination with jet pipes carried in said openings and means for directing jets at the lower ends of said pipes both laterally and vertically downward.

4. The foundation pier of claim 1 in combination with the devices referred to therein adapted to form a practically continuous annular hole in the material below the cutting edge of the pier, said pier having an interior dredging well through which the material in the cutting edge can be removed.

5. A hollow foundation pier having a wall around the exterior surface of said pier and spaced therefrom, and retaining means in the space between said wall and said pier and serving to unite said wall to said pier and to separate the annular space between said wall and said pier into separate sections and form guide and control means for devices extending downwardly through said space to the earth below said pier wall.

6. A foundation pier having a pier structure, an inner metal shell secured to the exterior of said structure and movable therewith and an outer metal shell spaced from said inner metal shell and rigidly secured thereto, the space between said shells being open at the bottom.

7. A foundation pier having a hollow central part and exterior walls sloping upwardly from their bottom outer edges to the hollow inner portions, vertical passages at the outer surface of said wall extending from the top to the bottom thereof and opening inwardly to the upwardly sloping bottom face of said wall, said passages being an integral part of said pier and forming a continuous annular space for the insertion of tools therethrough.

8. A foundation pier having a hollow central part and exterior walls sloping inwardly from their bottom outer edges to the hollow inner portions, vertical passages at the outer surface of said wall extending from the top to the bottom thereof and opening inwardly to the upwardly sloping bottom face of said wall, said passages being an integral part of said pier and forming a continuous annular space for the insertion of tools therethrough, and tools extending through said passages and movable to separate and discharge material inwardly below the sloping bottom of said pier wall.

In witness whereof, I have hereunto signed my name.

DANIEL E. MORAN.