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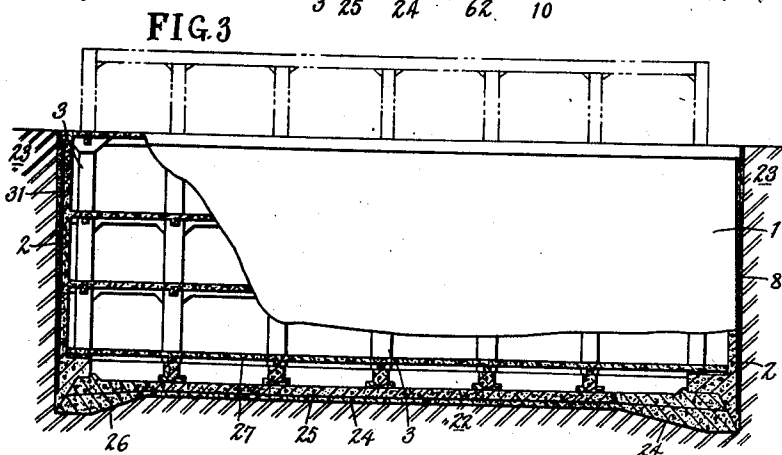
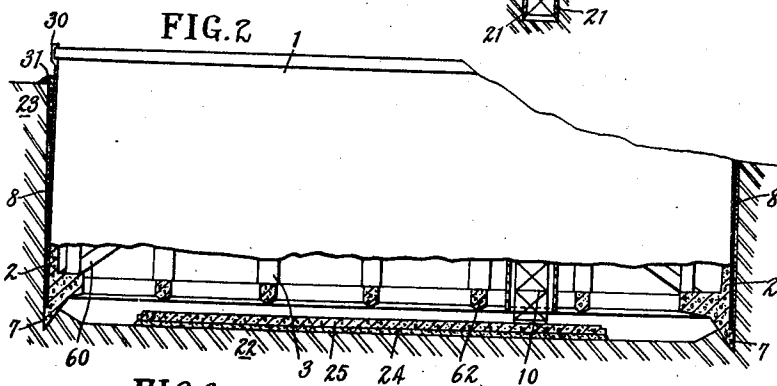
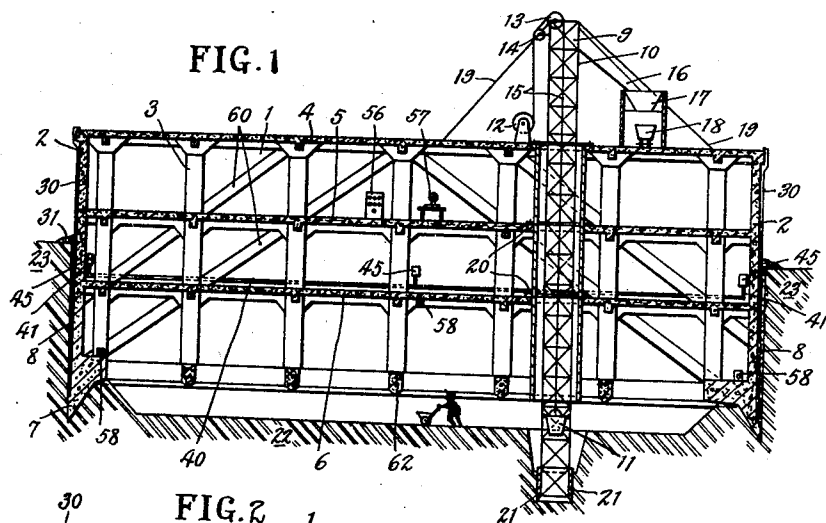
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2,213,169

CONSTRUCTION METHOD FOR UNDERGROUND STRUCTURES

Filed Feb. 13, 1939

3 Sheets-Sheet 1



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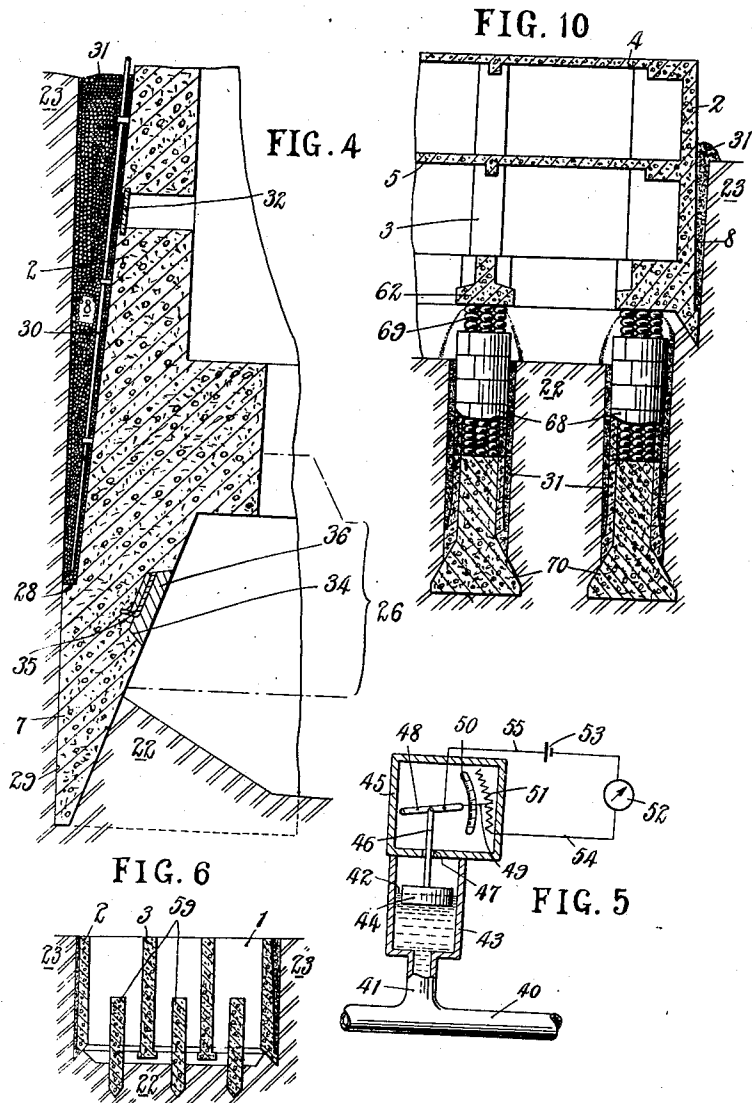
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CONSTRUCTION METHOD FOR UNDERGROUND STRUCTURES

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3 Sheets-Sheet 2



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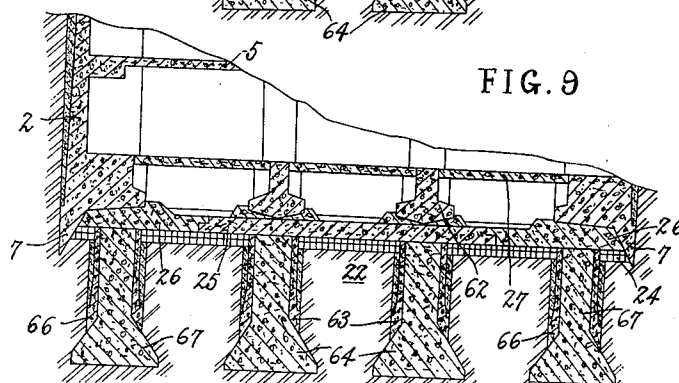
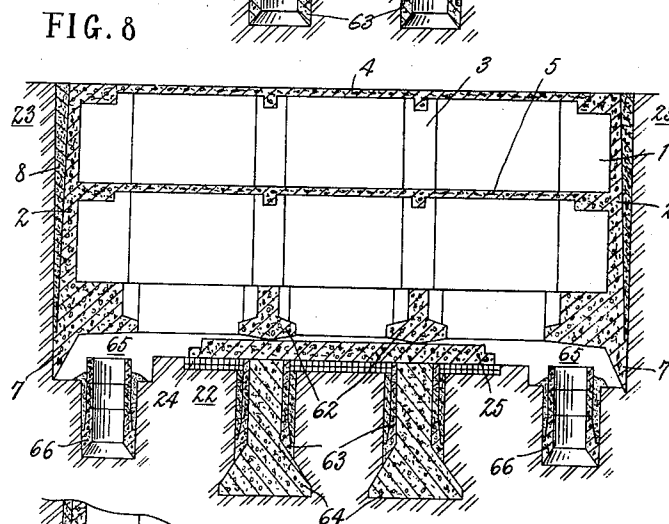
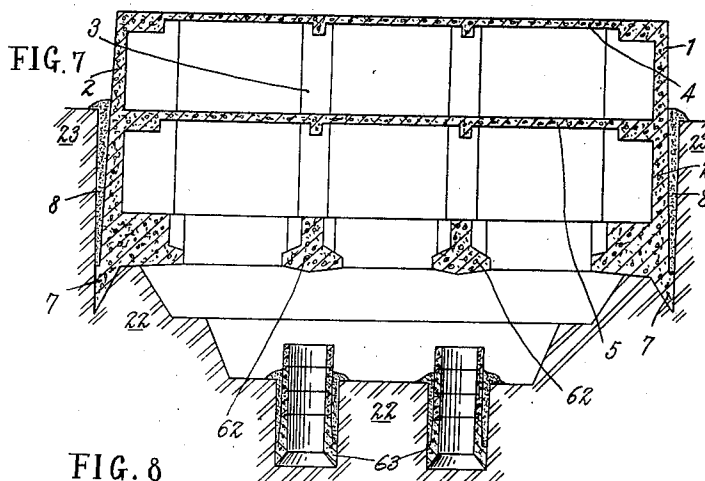
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CONSTRUCTION METHOD FOR UNDERGROUND STRUCTURES

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3 Sheets-Sheet 3



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CONSTRUCTION METHOD FOR UNDER-
GROUND STRUCTURES

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23 Claims. (Cl. 61—50)

My invention relates to improvements in the construction methods for underground structures.

According to heretofore methods, to construct 5
underground buildings such as basement of a building, it is customary first to do sheathing by sheet piling with logs or steel plates, to excavate the soil within said sheet piles, make a spacious hole by carrying out the earth and then to erect 10
a building from the bottom of said hole.

This method, however, has the following disadvantages; namely (1) the building work must be done within a limited space of excavation, which makes the work more complicated, difficult 15
and inefficient; (2) because there must be adequate space between the walls of said hole and the sidewall of a building, and on account of sheathing, a considerably larger area than is actually necessary for the building is required; in other words, this decreases the site utility rate 20
considerably; (3) the complicated and expensive protection work is necessary to check water gushing out of the excavation or water springing from other sources; and (4) because the subterranean water contained will be pressed out, if the adjoining ground has a building that will 25
give heavy load thereon said ground will be weakened; and, in some extreme cases, this will cause an inclination to the adjacent building.

Under present invention, the greater part of an underground structure such as basement, is constructed first on the ground upon which the building is to be erected. In this case it is better to omit the lowest slab, that is, all the floors 30
(excepting the lowest floor), sidewalls, columns, partitions and other parts are constructed on the ground, after which this entire semi-finished structure is made an open caisson and the soil underneath is excavated, and, taking advantage 35
of its own weight, the structure is gradually sunk to a desired depth. Then the structure is fixed to proper foundations, and finally the bottom floor is provided and detail finishing is done.

If necessary, additional building upon said 45
underground structure may be constructed, either while the said structure is in course of sinking or after the sinking is completed. It is usually better to follow the latter procedure but when the completion of a building is urgently required, in spite of some disadvantages, the former procedure is followed so as to complete the building 50
simultaneously with its sinking.

Under present method, because the structure will promptly sink and fill the hole caused by 55
excavation, horizontal pressure that comes from

an adjacent ground or an adjacent building will be supported by said sinking structure, and there will be almost no weakening of said ground or any inclination of said building. Also, as the hole 5
caused by excavation is instantly filled by the structure itself, there is almost no necessity of sheathing work that is customarily required. Another advantage is that this method allows of full use of a building site. Even for a building 10
as large as 50 meters square, by using this method, the site utility rate can be raised to 98%. In a city where cost of the ground is very expensive, a great saving can be made by adopting this method. Also, as the greater part of an under- 15
ground building can be assembled on the ground, it is easy to transport materials and to expedite the building work. In addition, as the sinking work of a building may be done within the building by excavating the bottom soil, construction work is not hindered by rain or other reasons. 20
Moreover, it is cool in summer and warm in winter and, if necessary, heating may be possible, for which reason even where intense cold prevails there is no fear of concrete freezing for foundation work. Thus, this method has the 25
advantage of saving the construction cost and of shortening the time for completing a building, besides a specific advantage of eliminating the sheathing work.

In putting the aforementioned methods into 30
practical use for large building construction, various difficulties that must be solved are encountered; namely, carrying out of the earth caused by excavation; friction between a sinking building and the adjoining ground; foundation 35
work, etc. all of which problems, however, the present invention has solved in a satisfactory manner.

The primary object of my invention is to construct an underground building at low cost and 40
by simple methods.

The second object of my invention is, in constructing an underground building, to increase the site utility rate.

The third object of my invention is, in constructing an underground building, almost to do 45
away with the sheathing work.

The fourth object of my invention is, in constructing an underground building, to obtain constructing methods that will have no fear of 50
weakening the adjoining ground or of weakening or inclining the building existing thereon.

The fifth object of my invention is to obtain an easy method by which to carry out the earth 55
resulting from the excavation of ground.

The sixth object of my invention is to make less the resistance by friction of a sinking building.

There are still other objects and particularities of my invention, which, together with the construction thereof, will be made clear in the following descriptions in connection with the accompanying drawings, wherein:

Figure 1 is a cross sectional view of an underground building in course of sinking process, showing one example of the use of my invention.

Figure 2 is a cross sectional view showing the aforementioned building sunk to a point slightly above the desired level.

Figure 3 is a cross sectional view of the aforementioned building already completed the sinking; the broken lines representing part of the building to be added thereon.

Figure 4 is an enlarged detail view showing part of the sidewall of the building.

Figure 5 is an enlarged view showing part of the equipment by which to measure the inclination of the building in course of sinking.

Figure 6 is a cross sectional view of the basement in course of construction for which modification of my invention has been applied.

Figures 7, 8 and 9 are cross sectional views showing respectively a basement in each stage of the sinking process, for which applying the methods under my invention, at a place where the solid ground exists somewhat lower than the level corresponding to the pre-arranged lowest position of the basement.

Figure 10 is a cross sectional view showing a basement in course of construction at a place where the ground site is extremely soft, for which applying the methods under my invention.

Needless to say, that the same marks designate the same parts will hold true with all the accompanying drawings herein cited.

Now, referring to the accompanying drawings details of my invention will be explained: 1 is the basement of a building in course of sinking process. First a shallow concave is provided by excavating slightly the surface of the ground where the greater part of the intended building is to be erected: by "greater part of the building" is meant sidewall 2, columns 3, floors 4, 5, 6, footing beam 62, and, if necessary, partitions. However, it is better first to omit the bottom floor and construct it after the sinking of the building has been completed because, by so doing, an available working space within the building required for excavating the soil can be increased to a maximum. At the end of the sidewall 2, a cutting edge 7, made of concrete, is provided, which will penetrate into the ground. 60 is the reinforcing bracing which will, in course of sinking of the building, enable the sidewall 2 to resist the horizontal pressure from the surrounding ground and to prevent the deformation of the entire building. The said bracing 60 is required only while the building is being sunk and should be removed immediately before the finishing of the building is started.

The outside of the sidewall 2 is slanted outwardly toward its bottom so as to provide a void 8 around the building as it sinks. Said void is filled with sands or small gravels in order to decrease the resistance by friction between the building and the surrounding parts. The best result is obtained by using round stones of almost uniform size, about one inch in diameter. These stones, acting as they do as ball bearings, will minimize the resistance by friction and, having

uniform volume ratio always between themselves and the void, do not require so much water as to weaken the surrounding ground, as is the case with sands. Also, after the building has completed its sinking, it is convenient to use these stones for reinforcing the building by pouring cement paste into the void so as to cement the building and the filler together.

If sand is used, it being irregular in size and having many sharp edges, the volume that it occupies will be considerably diminished when pressed or water is poured, besides having a large coefficient of friction. In addition, one will have great difficulty in pouring cement paste upon the sand and the permeation of such paste will never give satisfactory result. Regarding the detailed construction and the effect of sidewall 2 and cutting edge 7, these will be described later.

9 is an earth lifter having frame 10 (composed of steel angles), earth lifting bucket 11, winch 12 and pulleys 13, 14, and is intended for carrying out the earth caused by the ground excavation under the building. The earth lifting bucket 11 is, by means of a rope 15 and by way of pulleys 13, 14, connected to the winch 12, and, by operating said winch, lifts from time to time the bucket together with the earth accumulated therein, and discharges only the earth through the earth discharge pipe 16 to the damp hopper 17. The discharged earth is loaded on the hand-truck 18, etc. and carried to the outside of the building.

The earth lifter is installed at the time when the greater part of the building is constructed on the ground, passing vertically through all the floors 4, 5, 6, with its frame top projecting far above the top floor 4 and its bottom extending, first by digging in the bottom ground to some extent, slightly lower than the bottom of the sidewall 2, i. e. the lowest end of the frame is to be penetrated into the soil. At each floor the said frame is, by means of an arm 20, securely fixed thereto and the top is supported by stay 19. In this way, as the frame 10 is fixed and supported, and sinks, as the building is sunk, without requiring any special foundation or any complicated arrangement to prevent its collapse, which are indispensable to heretofore one.

It, therefore, is always in a readily usable condition and does away with the inconvenience of re-arranging its position from time to time as the ground is excavated. Surrounding plate 21, which is made of steel or concrete and which has a cutting edge at the bottom end, is fixed all around the lower part of the frame 10, in order not only to prevent the earth from breaking but also to make the surrounding plate 21 automatically penetrate into the soil as the earth lifter sinks with the building, thus making the descending movement of the said lifter easy and leading its direction of movement. As to the position of installing the earth lifter it is better to use a shaft where, after the completion of the building, an elevator will be installed.

After the greater part of the building basement is constructed on the ground and the earth lifter is installed to this basement, as described above, the bottom ground 22 of the building is excavated gradually and uniformly, either by man power or machinery, and the earth is discharged outside of the building by means of the earth lifter. The building will, as the ground is excavated, sink gradually by its own weight, during which process the cutting edge 7 at the

bottom of the sidewall 2 penetrates into the ground at the same time decreasing the resistance by building's sinking and accurately leading the sinking direction.

5 As the outside of the sidewall 2 forms an angle of outwardly inclination toward its bottom, a wedge-shaped void 8 is formed between the sidewall 2 and the adjoining ground 23 as the building sinks. This void is filled from time to time with sands, small gravels, etc. which will not only prevent the adjoining ground from breaking but will also decrease the resistance by friction of the sinking process and act as a buffer against horizontal pressure that the sidewall 2 will suffer from the outside.

10 As above described, the earth lifter descends as the building sinks, for which reason it is necessary to dig from time to time the ground underneath the lifter and to carry out the earth; it is better always to dig this part in advance so as to put it at a lower level than any other part. As explained above, because the earth lifter under present invention does not require any special foundation work and is only fixed to the existing building, the assembling is easy; requires no large space; has little fear of collapse and therefore the safety is great.

15 Also, not only it is possible to install the lifter directly to inside of the building, but the position of the lifter can be used as a shaft for elevator after the building is completed; carrying out of the earth is easy; because the lifter sinks as the building sinks, there is no need of re-arranging the lifter as the excavation progresses, which will allow the work to be continued without cessation, thus bringing about savings in time and labor as well as increased working efficiency.

20 When the basement, in this way, is gradually sunk close to a desired depth, the earth under those parts close to the sidewall 2 is left at their positions and the entire load of the building is caused to be supported only by said parts. Next, the spacious central portion of the ground is excavated and levelled, after which first laying broken stones over there and then pouring a preliminary layer 24 of concrete, the central foundation slab 25 is constructed thereon by pouring concrete. At this point there is no connection between the building and the central slab, which is shown in Figure 2. Also, at this point, as the work progresses the frame 10 of the earth lifter 9 is to be removed beginning with its bottom. Then, by taking out the earth under those parts close to the sidewall 2, which were left at their positions, the building is further sunk and placed upon the central slab 25. In this way, by fixing each column and the central slab 25 of the building, the entire load of the building is caused to be supported by the central slab 25.

25 Next, as shown in Figure 3, broken stones are laid and concrete is poured on those parts close to the sidewall 2, upon which is provided the circumferential slab 26, and said slab is connected with the central slab 25, sidewall 2 and cutting edge 7. Finally, the basement is completed by installing the bottom floor 27, removing the bracing 8 and doing detail finishing, as shown in Figure 3. To erect a building upon the basement, as shown with the broken lines of Figure 3, it is better to start its construction after this stage of work but, if necessary, it may be started while the basement is in course of sinking.

30 Figure 4 shows enlarged details of the basement sidewall 2 and the cutting edge 7 at the lower part of the former. As described above, outside

of the sidewall 2 forms, toward its bottom, an angle of gradual inclination, and where it connects with the cutting edge 7, as shown in 28, then connects to the vertical outside wall 29 of its outside projects in a staircase shape and cutting edge 7. Therefore, as the ground is excavated the building sinks and the cutting edge 7 will penetrate into the soil, thus decreasing the resistance by the sinking of the building. In other words, as by far the greatest load of the building is always centralized on the cutting edge 7 part, if the resistance at this part is reduced, the resistance by the sinking of the entire building will be reduced accordingly. The resistance at this part is very great, for example, in the case of a reinforced concrete building with three basement floors and measuring 2,000 square meters, even if the central part is excavated and the earth is entirely taken out, the building will not start sinking, unless the earth around the cutting edge 7 is removed. The vertical outside wall 29 of the cutting edge 7 will, while the building is sinking, lead the sinking direction and prevent the building from inclining.

35 Because the sidewall 2 is slightly expanded toward its bottom, as the building sinks it will form a void around it, as shown in 8. This void is filled with sands, small gravels, etc. as described above.

40 If necessary, to the outside of the sidewall 2, a pipe 30 may be provided through which water can be poured into the said sands or small gravels 31 in order to further decrease the resistance by friction. After the building has completed the sinking these pipes may be used for pouring cement paste into the small gravels 31 in the void 8 to cement these together. 32 is a glass window provided at the sidewall 2 for the purpose of examining from inside of the building, the arrangement of sands or small gravels, conditions of the water pouring, or the pouring of the cement paste, etc. Upon the completion of the building these are to be filled from inside. Those shown in broken lines represent where the circumferential slab 26 is to be installed.

45 Inside the cutting edge 7 there is provided a cavity 34, to the bottom of which another half of the waterproofing board 35, of which one half is previously buried in the cutting edge 7, is bent and contacted. While this cavity 34 is filled with wooden plate 36 in course of the sinking process, after which sinking is completed said wooden plate 36 is removed and the exposed, bent half of the waterproofing board 35 is straightened, concrete pouring is done to the circumferential slab 26 and the bended half is buried in said circumferential slab 26, so that the waterproofing board 35 extends over both the cutting edge 7 and circumferential slab 26 and checks the subterranean water that might permeate through the contact surface of these two parts.

50 Next, the method by which the building is caused to do uniform sinking at all parts, or the method of avoiding any inclination of the building will be explained. In sinking, whatever precaution may be taken, a more or less slant will be caused to a building. This is because the excavation is not done with uniformity and also the nature of soil at all parts is not the same. However, it is apparent that any inclination of the sinking building will have bad effect on both the adjoining ground and the building itself. For this reason, it is necessary to provide some means by which excavation can at all times be made by accurately measuring and adjusting even

the slightest inclination of the building so that the sinking of the building may proceed uniformly at all parts.

Under my invention an endless pipe 40 with a diameter of at least one inch, is encircled, almost horizontally, all through the inside of the wall and fixed to the building. On said endless pipe, vertical pipes 41 are provided at several points with their inside correlating with that of the former pipe. Water is filled in the endless pipe to the level that it will reach about half the height of said vertical pipes, and closed airtight.

If the building inclines, the relative position of the pipe and the water level of the vertical pipes will be changed. Therefore, by graduating the vertical pipes and a standard vertical pipe, and by comparing a difference shown in the scales the relative level of any part of the building to the part where the standard pipe is provided, may be instantly read.

Figure 5 shows detailed construction of part of this equipment. The upper part of the vertical pipe 41 is somewhat expanded and forms the expanded room 43. Water is filled to the endless pipe 40 so that its water level 42 reaches the said expanded room 43. On the water level 42 a proper float 44 is put. A measuring box 45, which is shut almost airtight, is fixed to the expanded room 43 and connects to the expanded room 43 only by a hole 47 large enough for the upper end of the float lever 46, whose bottom is secured to the float 44, to move therein in response to the up and down movement of the float 44 in the expanded room 43. The purpose of shutting these pipes airtight from the outside is to prevent the volume of water inside the pipe from changing by evaporation.

The top of the float lever 46 that moves either up or down according to the relative movement of the water level 42, is pivoted, and transmits the movement of the water level, to the operating lever 48, whose one end is pivoted to the measuring box 45. The indicator 49, which is provided at the end of the operating lever 48, will, in cooperation with the scale board 50, indicate the relative movement of the water level 42 and the vertical pipe 41, i. e. movement of the water level.

The end of the indicator 49 will slide on the slide rheostat 51, whose terminal is connected, by means of the lead wire 54, to the terminal of the battery 53 by way of ammeter 52. Also, the indicator 49 is electrically connected, by way of the operating lever 48 and lead wire 55, to the other terminal of the battery 53, thus completing an electrical circuit. By taking advantage of the resistance change of the circuit due to the movement of the indicator 49, the movement of water level 42 is electrically shown on the ammeter 52.

The object of the switch-board 56 shown in Figure 1 is to centralize these ammeters 52 to one switch-board for the purpose of making a remote measuring at one central point. Said switch-board 56 is installed at a point within the building such as, for instance, in a commanding room, from where by means of a microphone 57 instructions or danger and other signals are given to the workers. 58 is a speaker installed at a working chamber intended for broadcasting news through the microphone.

Figure 6 shows modification of the present invention wherein after the building has been sunk

to a desired depth several foundation piles 59 are sunk or struck into the bottom ground between each column of the building, and then these are fixed to the building by means of the foundation slab, and finally each floor is installed.

Figures 7, 8 and 9 show modifications of this invention. Generally, foundation work of a building is greatly affected by the nature of the ground on which it is built. In Figures 2 and 3 it is shown that, upon the bottom ground 22, only broken stones are laid down and then concrete is poured thereon, upon which central foundation slab 25 and circumferential foundation slab 26 are directly installed. For such foundation work the bottom ground 22 must be sufficiently solid nature to support the entire building.

If such solid ground exists beneath the bottom level of the building, that is, lower than the foundation slab, it is necessary to provide foundation work of a different kind; namely, first, many foundation piles whose bases are put into said solid ground are provided, upon which the foundation slab must be installed, as shown partly in Figure 6. However, to provide foundation piles between each column of the building, as shown in Figure 6, it is very disadvantageous from the standpoint of construction and the ideal way to do is to provide them directly under each column.

Figure 7 shows basement that was constructed and sunk close to a pre-arranged level, in the same manner as in Figure 1 for which, however, details of lifters, bracing, etc. are omitted.

When, in this manner, the basement is sunk to a considerable degree and reaches close to the pre-arranged level, only earth near the cutting edge 7 is left untouched so as to support the entire load of the building by said earth and, by removing only the earth at the central portion by excavation, a cavity 61 is provided. Then, directly under the footing beam 62 and also each column 3 one each central well-curb 63, preferably a combination of a number of short well-curbs, is sunk.

The bottom of said well-curbs is enlarged to enable them to cause a void around them as they sink, and said void is filled with small gravels with the object of minimizing resistance by friction. Also, it is preferable to provide a cutting edge at the bottom of the well-curbs 63 so that it may sink by its own weight as the bottom ground is excavated. To sum up, just as the basement itself is made one open caisson, each well-curb is made one well caisson and sunk; and when the bottom end of the central well-curb 63 reaches solid ground, the soil beneath same is further excavated wide, and the inside of the well-curbs is filled with concrete, making each of these well-curbs a central foundation pile 64 respectively.

Upon the central foundation pile a layer of broken stones 24 and then a central foundation slab 25 are provided, as shown in Figure 8. Then the ground near the cutting edge 7 is excavated, the basement is again sunk gradually and finally put quietly on the central foundation slab, causing the entire load of the building to be supported by said slab.

Next, the soil near the cutting edge 7 is further excavated and is provided a cavity 65, from which part a number of circumferential well-curbs 66 are sunk in the same way as central well-curb 62, as shown in Figure 8.

The inner part of the circumferential well-curb 66 is then filled with concrete to make same a circumferential foundation pile 67, and a circumferential foundation slab 26 is provided by arranging a layer of broken stones. Then the foundation slabs 25, 26 are connected together, to which the cutting edge 7, each foundation pile 64 or 67, and the foot-ring beam 62 are also connected; in this manner the building is stabilized on solid ground by means of all the foundation piles. Finally the bottom floor 27 is provided, as shown in Figure 9.

If solid ground exists slightly beneath the bottom level of the building, there is no necessity of using a combination of a number of short well-curbs as foundation piles. In such case a long foundation pile or well-curb may be used, but a cavity under the building must be sufficiently spacious to allow its sinking.

Figure 10 is a cross sectional view showing only the essential part of a basement in course of sinking, for which applying the methods under my invention where the ground is extremely soft. Where the ground is soft, while the greater part of a basement is being constructed on the ground surface, even before the excavation of its bottom ground is started, there is danger that the structure will start sinking, in addition to which causing an uneven inclination of said structure. For these reasons it is impossible to expedite the work without taking some steps.

For such soft ground, first a number of foundation piles 70 are sunk, with their bottoms breaking into the solid ground and their tops reaching the pre-arranged level which the building bottom should reach. The well-curbs 68 are piled up on said foundation piles 70 to reach the ground surface, filling their inside with bags 69 full of sand.

In this way the piles 70 and sand bags 69 will form a kind of provisional foundation that will prevent the building from making undesired sinking. To set the building sinking, a cavity is provided by excavating its bottom soil, and the combined well-curbs are removed one by one from the top, leaving the sand bags 69 as they are. Then, make a small hole in the uppermost sand bag and the sand filler, pressed by the load of the building, will come out gradually; as the sand is exhausted the building will start sinking gradually. Thus, the sand bags 69 serve the two purposes of temporarily supporting the building and of adjusting its sinking. After the building has sunk close to the prearranged position the central foundation work and circumferential foundation work are performed alternately in the same manner as described above, for which reason detailed explanations are omitted.

I do not intend that the present invention shall be restricted to the specific constructing methods, details of which are herein set forth, as various modifications thereof may be effected without departing from the spirit and scope of the invention. I desire, therefore, that only such limitations shall be imposed as are indicated in the appended claims.

I claim:

1. Constructing methods of basements and other underground structures, in which the greater part of such building is constructed in advance on the ground surface and, by making the entire structure one open caisson, excavating the bottom soil of such structure and taking advantage of its own weight, said structure is caused to sink to a desired level, after which fixing said

structure upon a foundation and then finishing its detail parts.

2. Constructing methods of basements and other underground structures, in which the greater parts of such structure such as, all floors (excepting the bottom floor), sidewall, columns, and the like, are constructed in advance on the ground surface and, by making the entire structure one open caisson, excavating the bottom soil of such structure, and taking advantage of its own weight, said structure is caused to sink to a desired level, after which fixing said structure upon a foundation and then finishing its detail parts.

3. Constructing methods of basements and other underground structures as mentioned in claim 1, in which bracings are provided diagonally, between the vertical members, before the sinking of said structure starts, said bracings to stand the horizontal pressure coming from the ground adjoining said structure, and being removed after the structure has finished the sinking.

4. Constructing methods of basements and other underground structures as mentioned in claim 1, in which an earth-lifter is installed vertically to the structure for the purpose of carrying out the earth caused by the ground excavation underneath said structure, said earth-lifter being passed through all the floors of said structure and being secured only at each of said floors to enable it to sink together with said structure.

5. Constructing methods of basements and other underground structures as mentioned in claim 1, in which the cutting edge is constructed at the bottom end of the sidewall of said structure, providing inside of said cutting edge a cavity, and to the bottom of said cavity one half of the waterproofing board being bent and contacted, with another half thereof being previously buried in the cutting edge, and, during the sinking course of said structure, said cavity to be filled with some material but after the sinking is completed, said material to be removed, after which one half of said bent waterproofing board to be straightened and buried in the circumferential slab so that it will check the subterranean water that might permeate through the contact surface of the cutting edge and the circumferential slab.

6. Constructing methods of basements and other underground structures as mentioned in claim 1, in which after said structure has been sunk to a desired depth, several foundation piles are sunk or struck into the bottom ground of said structure, and then these to be fixed to said structure by means of the foundation slab.

7. Constructing methods of basements and other underground structures as mentioned in claim 1, in which, leaving the earth under those parts close to the sidewall of said structure at their positions and causing the entire load of said structure to be supported by said parts, said structure is sunk close to a desired depth; then, upon constructing the central foundation slab by excavating the spacious central portion of the ground, the earth under those parts close to said sidewall and left at their positions, is taken out and said structure is caused further to sink and placed upon said central foundation slab, and finally constructing the circumferential foundation slab, each of said foundation slabs and said structure to be connected together.

8. Constructing methods of basements and other underground structures as mentioned in claim 1, in which when said structure reaches close to the pre-arranged level, only the earth

near the cutting edge is left so said earth may support the entire load of said structure, and removing by excavation only the earth at the central portion a cavity to be provided; then directly
 5 under each column the central foundation pile is sunk, constructing upon which the central foundation slab and, by further excavating the earth near the cutting edge, another cavity to be provided, through said cavity a number of
 10 circumferential foundation piles being sunk in the same way as the central foundation piles, constructing upon which the circumferential foundation slab, and finally each of said foundation slabs and said structure to be connected
 15 together.

9. Constructing methods of basements and other underground structures as mentioned in claim 1, in which when said structure reaches close to the pre-arranged level only the earth
 20 near the cutting edge is left so said earth may support the entire load of said structure, and removing by excavation only the earth at the central portion a cavity is provided; then directly under each column the central well-curb, a combination of a number of short well-curbs, is sunk,
 25 filling their inside with concrete to make them central foundation piles, constructing upon which the central foundation slab, and, by further excavating the earth near the cutting edge, another cavity to be provided, through said cavity a number of circumferential well-curbs, a combination of a number of short well-curbs,
 30 are sunk in the same way as the central well-curbs filling their inside with concrete to make them circumferential foundation piles, constructing upon which the circumferential foundation slab, and finally each of said foundation
 35 slabs and said structure to be connected together.

10. Constructing methods of basements and other underground structures as mentioned in claim 1, in which first a number of foundation piles are sunk with their bottoms breaking into the solid ground and their tops reaching the
 40 pre-arranged level which the bottom of said structure should reach, upon each of said foundation piles supporting members for said structure being piled up to reach the ground surface, then constructing said structure upon said
 45 supporting members that will serve as a temporary foundation for said structure, and ground excavation being started, thereby adjusting the gradual sinking of said structure by removing said supporting members one by one from the top.

11. Constructing methods of basements and other underground structures as mentioned in claim 1, in which first a number of foundation piles are sunk with their bottom breaking into the solid ground and their tops reaching the
 50 pre-arranged level which the bottom of said structure should reach, upon each of said foundation piles a well-curb consisting of a number of short well-curbs being piled up to reach the ground surface, filling inside of said well-curbs
 55 with bags full of sands; then construction of said structure and ground excavation being started and said combined well-curbs to be removed one by one from the top, and adjusting the gradual sinking of said structure by perforating said sand bags one by one and causing
 60 the sand filler to be exhausted by the load of said structure.

12. Constructing methods of basements and other underground structures as mentioned in claim 1, in which construction of a building upon

the basement is started while the basement is in course of sinking.

13. Constructing method of the character described, comprising the steps of constructing a part of a building on the ground in the form of an open caisson structure, excavating the bottom soil of said structure, causing said structure to sink by its own weight to a desired level, constructing the outer side walls of the structure to slant inwardly so as to produce a void around the building as it sinks, providing an earth-lifter to extend through all floors of the structure and sinking therewith, causing the structure to rest upon a foundation, and then finishing its detail parts.

14. Constructing method of basements and other underground structures as claimed in claim 13 comprising constructing a cutting edge at the bottom end of sidewalls constituting said structure, making the outside of said sidewalls to project in a staircase shape, and then connecting said staircase wall to the vertical outside wall of said cutting edge.

15. Constructing methods of basements and other underground structures as mentioned in claim 13, in which the void, to be provided around said structure as it sinks, is automatically filled with small round gravel of almost uniform size, about one inch in diameter.

16. Constructing methods of basements and other underground structures as mentioned in claim 13, in which the void is automatically filled with sands and, in order to decrease friction to be caused by the sinking of said structure, water is poured into said sands through pipes provided at the outside of the sidewalls so as to decrease the volume occupied by the sands.

17. Constructing methods of basements and other underground structures as mentioned in claim 13, in which, after the building has completed the sinking, pipes are provided at the outside of its sidewall through which cement paste is poured into the gravel put in the void.

18. Constructing methods of basements and other underground structures as mentioned in claim 13, in which a surrounding plate with cutting edge is provided all around the lower part of the earth-lifter, in order not only to prevent any earth breaking but also to make it automatically penetrate into the soil as said earth-lifter sinks together with the structure.

19. Constructing methods of basements and other underground structures as mentioned in claim 13, in which a glass window is provided at the sidewall of said structure for the purpose of examining from inside of said structure the conditions in the void formed around said structure.

20. In constructing method for basements and other underground structures, the steps of constructing at least a part of a structure on the ground, in the form of an open caisson, excavating the bottom soil of the structure, causing said structure to sink by its own weight, providing foundation means comprising piles and well-curbs underneath the sinking structure, causing the structure to rest upon the foundation means, and finally finishing the detail parts.

21. Constructing methods of basements and other underground structures as mentioned in claim 20, in which the cutting edge is constructed at the bottom end of the sidewall of said foundation pile or well-curb, and the outside of said sidewall being made to project in a staircase shape and then connected to the vertical outside wall of said cutting edge.

22. Constructing methods of basements and other underground structures as mentioned in claim 20, in which the void, to be provided around said foundation pile or well-curb as it sinks, is automatically filled with small round gravels of almost uniform size.

other underground structures as mentioned in claim 20, in which after said foundation pile or well-curb has completed the sinking, through the pipes provided at the outside of the sidewall, the cement paste is poured into the gravels in the void.

23. Constructing methods of basements and

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