

No. 713,519.

Patented Nov. 11, 1902.

C. SOOYSMITH.

METHOD OF BUILDING TUNNELS, SHAFTS, &c.

(Application filed Dec. 23, 1901.)

2 Sheets—Sheet 1.

(No Model.)

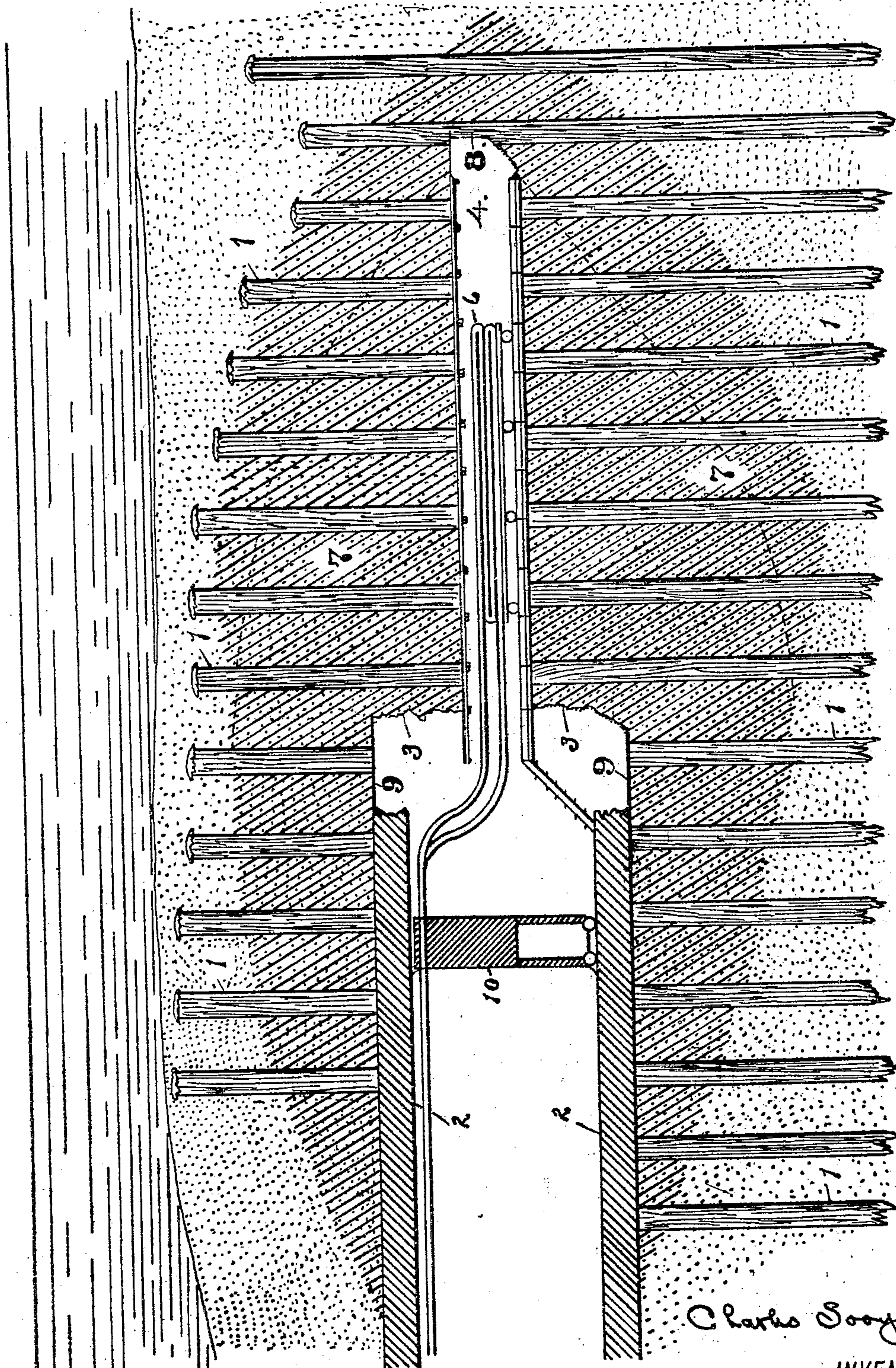


Fig. 1.

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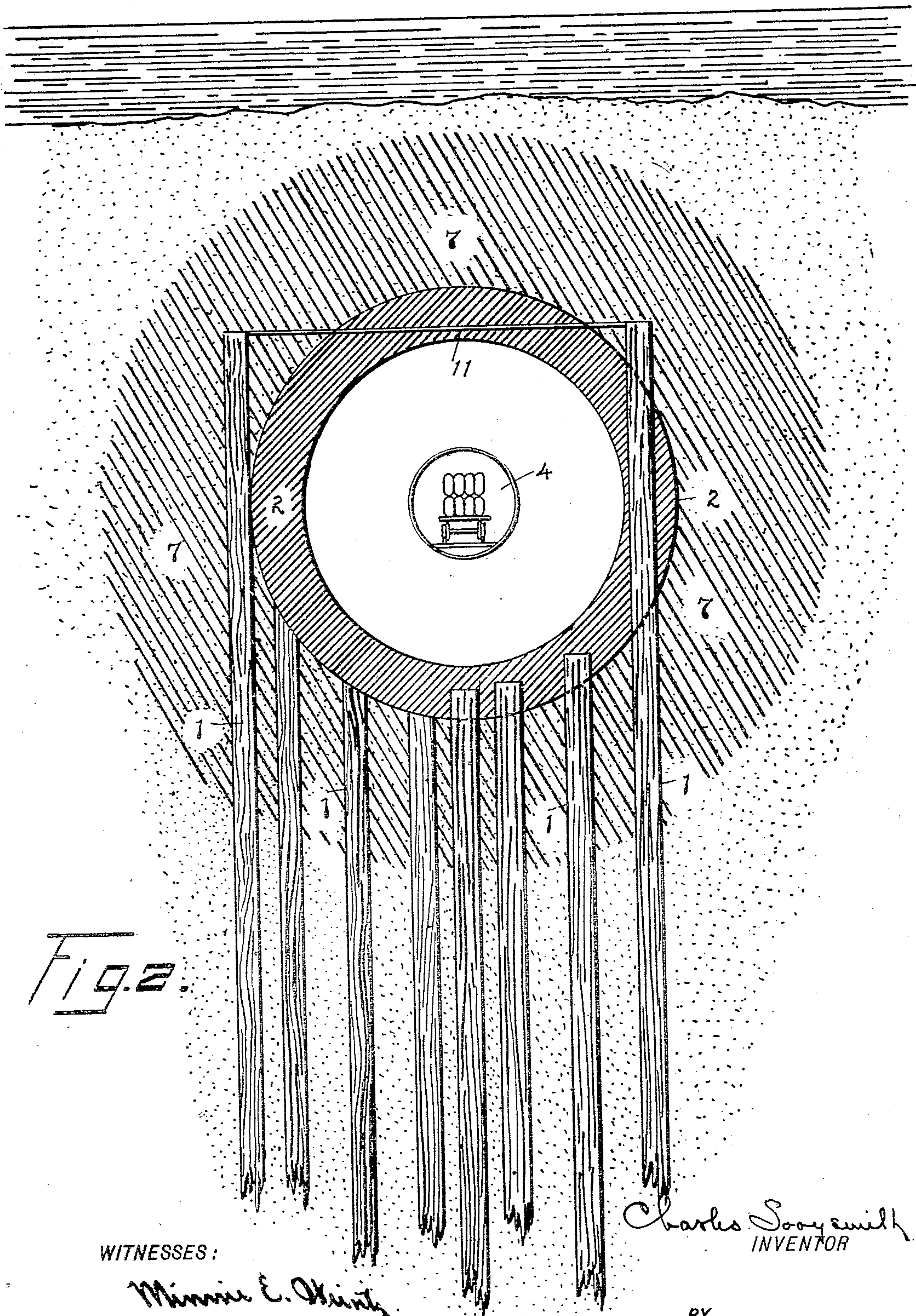


Fig. 2.

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CHARLES SOOYSMITH, OF NEW YORK, N. Y.

METHOD OF BUILDING TUNNELS, SHAFTS, &c.

SPECIFICATION forming part of Letters Patent No. 713,519, dated November 11, 1902.

Application filed December 23, 1901. Serial No. 86,946. (No model.)

To all whom it may concern:

Be it known that I, CHARLES SOOYSMITH, a citizen of the United States, and a resident of the city of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in the Method of Excavating and Constructing Tunnels or other Subterranean or Submarine Structures and in the Structures so Constructed, of which the following is a specification.

My invention relates to the process of constructing tunnels, shafts, or other excavations, and especially to tunnels or excavations in soft or yielding or water-bearing materials, and has more particular reference to those instances where the freezing method may be advantageously or necessarily employed.

The objects of my invention are to provide a practical method of excavation and construction which shall be at once economical, easy, rapid, safe, and stable. These objects I attain by the use of the process and devices illustrated in the accompanying drawings and described in the following specification, and claimed hereinafter.

In the drawings like figures of reference refer to like parts throughout the respective views.

Figure 1 is a longitudinal sectional view of the head of an excavation or horizontal tunnel—for example, under a river—showing the methods of and devices for freezing the material and the method of and means for supporting and anchoring the completed structure. Fig. 2 is a cross-section of the tunnel, showing said methods and means for anchoring and supporting.

Heretofore methods of excavation in loose or water-bearing materials, while in some cases utilizing the well-known method of freezing the soil in advance of the work, have not provided for a stable foundation or against the strains set up in the completed structure by the settling and undermining of the work. Moreover, heretofore, and especially as indicated in the Letters Patent No. 417,288, heretofore granted to me on December 17, 1889, the freezing effect was produced in a tube of comparatively small area and ex-

tent, which was with some difficulty forced into the material to be excavated and which on account of the limited area and dimensions failed to attain to an entirely satisfactory extent the result desired, thus rendering the work more tedious, slow, and relatively difficult.

By this invention I am enabled to work more freely, rapidly, and effectively, with a greater space or area for the freezing process, and am enabled to secure a more solid, stable, and durable foundation for the finished structure. Of course it is much easier, cheaper, and quicker to construct a small tunnel than a large one, so by advancing my pilot-tunnel and then freezing and proceeding with the larger I attain some of the objects above specified.

Referring to the figures, 1 1 are piles or other supports arranged on the line of the structure and preferably placed in position prior to its actual construction.

2 is the main structure of the completed tunnel.

3 is the heading or face of the excavated material.

4 is the pilot-tunnel, penetrating the mass of soft material.

5 is a car or traveler adapted to bear a refrigerating device and to be adjustably moved within the pilot-tunnel.

6 is the refrigerating device, which may consist of any means for producing sufficient cold within the pilot-tunnel so as to freeze or solidify the surrounding soft material.

7 represents the frozen or solidified soil in contact with the pilot-tunnel; 8, the heading of the pilot-tunnel; 9, the frozen soil excavated to the final line, but without the tunnel structure in place; 10, a movable partition adapted to confine the cold to the working chamber.

Fig. 2 shows some of the piles cut off, so as to conform to the exterior surface of the tunnel, while about the heads of the others the tunnel is itself built, thus incorporating a portion of some of the piles in the body of the tunnel itself. In Fig. 2 I have also indicated a tie-bar 11, which I may use to still further strengthen and secure the tunnel to the piles. I have found that former methods,

consisting in the use of a small pilot-tube only large enough to contain the refrigerating fluid, were not capable of accomplishing the work as rapidly as desired. I therefore
5 replace them by constructing one or more pilot-tunnels, preferably of steel, wood, or other material, built in sections of concrete, brick, or other material and of a diameter sufficient to permit one or more men to work therein.
10 This tunnel is started in any of the well-known ways into the approximate center or other desired point of the heading or face or in proximity thereto; but before starting this pilot-tunnel I prefer to drive or otherwise
15 place a sufficient foundation of piles or other suitable supports in the proposed line of construction, though I may in some cases omit artificial foundations entirely and carry out my process without them. Where these are
20 employed, they may be so placed that their tops or heads are approximately on the line of the bottom of the completed tunnel or extend in part or entirely over its entire cross-sectional area. If in the latter case, as the pilot-
25 tunnel is advanced these piles or supports are encountered and so much of them successively removed as to permit the continual progression of the work. Upon the advance of the main structure those portions remaining
30 within the cross-sectional area are either entirely removed, so as to allow the masonry or substance of the finished tunnel to rest upon their heads, or those of them that are suitably located may be inclosed within its walls
35 or otherwise serve to support and secure it, some methods of which are indicated in Fig. 2. When the pilot-tunnel is sufficiently advanced, a track may be laid therein, on which a carrier supporting coils or pipes or other re-
40 frigerating device may be supported and the whole moved from end to end. On this track also cars may, if desired, be run to facilitate the removal of the soil as it is excavated. The refrigerating means in the pilot-tunnel are
45 adapted to so solidify the surrounding soil that it may be removed not only in advance of the pilot-tunnel, as at 8, but also at the face 3 of the main excavation and at the portion 9 of the excavation before the lining is
50 in place. It will be evident that as the material at 8 is excavated and removed new sections of the pilot-tunnel may be put in place, thus continually keeping the latter well up to the end of the excavation, and it is equally
55 evident that as the excavation of the heading 3 of the main tunnel is advanced the sections of the pilot-tunnel, which will then be left exposed at 3, may be detached and used over again at 8.
60 It will be understood that the pilot tunnel or tunnels may be built complete before the refrigeration is commenced, or their excavation and construction may be going on at the same time that the refrigeration in the finished
65 portion is taking place. After a certain time the material about the pilot-tunnel

will have become frozen and to such a distance that the excavation may be made of sufficient size for railway or other traffic, the frozen material remaining outside of this excavation serving as a barrier to inflow of material or collapse of the surrounding earth. The movable partition 10, if used, serves to
70 confine to any desired extent the cold air to the heading or uncompleted portions of the tunnel. This partition can of course be provided with the usual and necessary doors and openings for various purposes.

I do not confine myself to the use of any particular material, shape, size, or proportions either of the tunnel or other coöperating or accessory parts, nor their exact indicated arrangement or positions, nor do I confine myself in the use of this process to any
80 particular class of work, as submarine tunneling, or to any particular direction, as the horizontal, as it is evident that variations from the exact features here shown may not depart from the essential features of my invention, nor do I confine myself to the use of
85 any particular method or way of driving the piles or otherwise placing the supports and anchorages, nor of constructing or advancing the pilot-tunnel or the tunnel itself, or the particular way or means for freezing, nor do
90 I limit myself to the use of any tangible means or device for freezing situated in the pilot-tunnel or elsewhere, as I may perform the operation of freezing by means of cold air or other gases or any other vehicle of cold or
95 freezing agent by which the result is accomplished, and the apparatus or means for producing such cold need not be situated in the pilot-tunnel or main tunnel itself.

Where I have used in the specification or
100 claims the words "means for freezing," I wish it to be understood that I include in this a vehicle of cold, as cold air, gas, brine, or any other substance or medium by which the freezing effect is produced. It should also be un-
105 derstood that while I prefer to first place my supports—as, for instance, piles—in the line of the proposed excavation I do not limit myself to this exact order in the steps of the process, as the foundation may be put down
110 at a subsequent time—as, for instance, after the completion of the main tunnel or during any step of the process—nor do I confine myself to the use of piles in my invention, as I may use pillars or other means of support, or
115 omit them all. Moreover, I may vary the means for excavating the material frozen or otherwise, as by digging, blasting while frozen, or thawing and removing while soft by means well known or otherwise and in part particu-
120 larly set forth and claimed in the Patents No. 340,162, granted to me April 20, 1886, and No. 340,161, granted on same day. Therefore while I do not claim, broadly, the method of tunneling by means of freezing the soil nor
125 do I claim here the tunnel itself as constructed by this method, as that forms the subject-

matter of an application for an improvement in tunnels filed by me March 3, 1902, serially numbered 96,359,

What I do claim, and desire to protect by Letters Patent, is—

1. The method of excavating which consists in first placing a plurality of supports in the line of the proposed excavation; second, constructing one or more pilot-tunnels; third, introducing freezing means into the pilot-tunnel; fourth, excavating the frozen soil, substantially as described.

2. The method of constructing tunnels, which consists in first placing a plurality of supports in the line of the proposed tunnel; second, constructing one or more pilot-tunnels; third, freezing the surrounding soil by means introduced into the pilot-tunnel; fourth, excavating through the frozen material to the tunnel-line; fifth, constructing the tunnel, substantially as described.

3. The method of constructing tunnels which consists in first driving piles in the line of the proposed tunnel; second, constructing one or more pilot-tunnels; third, freezing the soil about the pilot-tunnel and heading of the main tunnel; fourth, excavating said frozen soil to the required extent; fifth, constructing the main body of the tunnel, substantially as described.

4. The method of constructing tunnels in water-bearing material which consists in first driving piles in the line of the proposed tunnel; second, constructing one or more sectional pilot-tunnels of sufficient size to permit men to work therein; third, introducing into the pilot-tunnel a means for freezing by which the surrounding and adjacent material to be excavated may be solidified; fourth, freezing said material; fifth, excavating the material and piles in advance of the pilot-tunnel and in advance of the main tunnel; sixth, constructing the walls of the main tunnel; seventh, advancing the pilot-tunnel always ahead of the main tunnel, substantially as described.

5. The method of constructing a tunnel or other subterranean or submarine structure which consists in first, constructing a pilot-tunnel, of sufficient size to permit excavation from within the same; second, freezing the surrounding and adjacent material; third, excavating the same; fourth, completing the structure, substantially as described.

6. The method of constructing a tunnel or

other subterranean or submarine structure which consists in first, placing supports in the proposed line of the same; second, constructing a pilot tunnel or tunnels through or over the same; third, freezing the surrounding and adjacent soil; fourth, excavating the latter and the supports to the approximate dimensions of the finished tunnel; fifth, constructing the tunnel on the supports, substantially as described.

7. The method of constructing a tunnel or other subterranean or submarine structure, which consists in first, driving piles on the proposed line thereof; second, building the structure upon said supports and incorporating the latter or some of the latter in the body of the structure, substantially as described.

8. The method of constructing tunnels or other subterranean or submarine structures, which consists in, first, constructing one or more pilot-tunnels, of sufficient size to permit excavation within the same; second, freezing the surrounding and adjacent soil by means introduced into the pilot-tunnel; third, excavating the soil; fourth, constructing the body of the structure, substantially as described.

9. The method of constructing a tunnel which consists in first, preparing a foundation; second, freezing the soil immediately over the same; third, excavating the tunnel; fourth, constructing the lining of the same, substantially as described.

10. The method of constructing tunnels which consists in, first, preparing a foundation; second, freezing the soil over the same; third, excavating a tunnel through the frozen material; fourth, constructing the lining of the tunnel upon the foundation; fifth, securing the lining to the foundation, substantially as described.

11. The method of constructing tunnels which consists in first, preparing the foundation; second, constructing one or more pilot-tunnels; third, freezing the surrounding soil; fourth, excavating said frozen soil to the required extent; fifth, constructing the main body of the tunnel, substantially as described.

Signed at New York, in the county of New York and State of New York, this 20th day of December, A. D. 1901.

CHARLES SOOY SMITH.

Witnesses:

HENRY W. KENNEDY,
EDW. T. RAPALLO.