

No. 755,956.

PATENTED MAR. 29, 1904.

C. SOOYSMITH.

METHOD OF CONSTRUCTING TUNNELS, SHAFTS, OR OTHER EXCAVATIONS.

APPLICATION FILED FEB. 1, 1904.

NO MODEL.

2 SHEETS—SHEET 1.

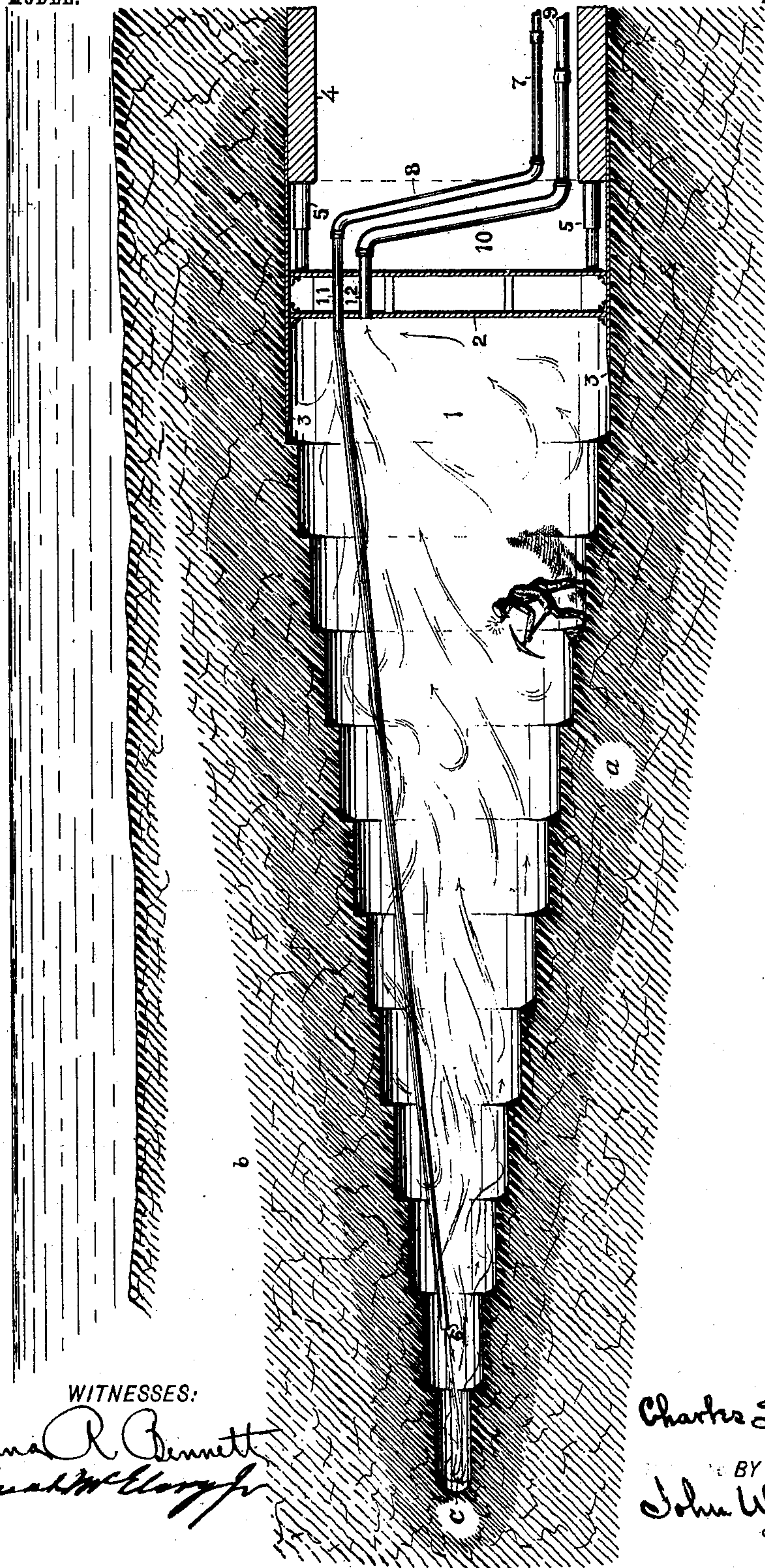


Fig. 1.

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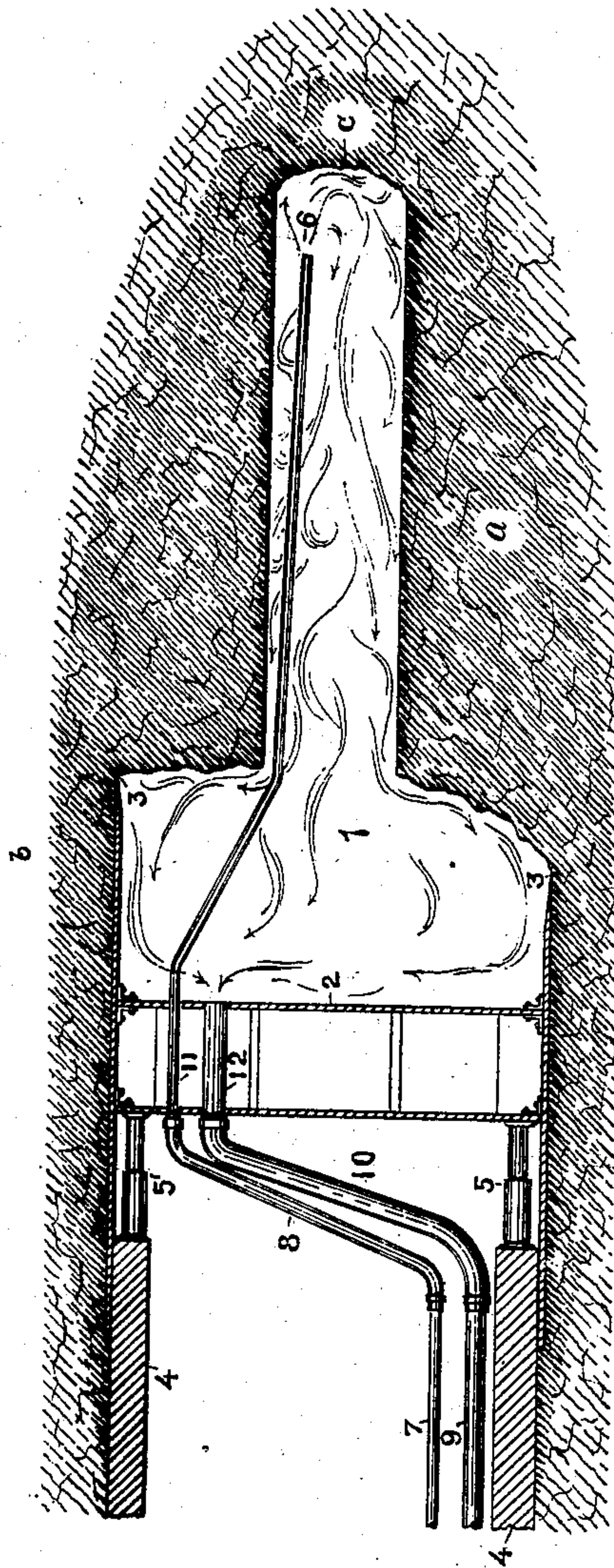


Fig. 2.

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CHARLES SOOYSMITH, OF NEW YORK, N. Y.

METHOD OF CONSTRUCTING TUNNELS, SHAFTS, OR OTHER EXCAVATIONS.

SPECIFICATION forming part of Letters Patent No. 755,956, dated March 29, 1904.

Application filed February 1, 1904. Serial No. 191,448. (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 New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Methods of Constructing Tunnels, Shafts, or other Excavations, of which the following is a specification.

My invention relates to the method 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 increase the safety, efficiency, economy, and the speed of tunneling, submarine or subterranean. These objects I attain by the use of the processes and devices illustrated in the accompanying drawings and described and claimed hereinafter.

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

Figure 1 is a longitudinal sectional view of the heading of an excavation or horizontal tunnel under a river embodying my invention and applied as described in part in the patent to myself and E. L. Abbott, No. 417,288, of December 17, 1889. Fig. 2 represents a modification of my invention, in which I employ a pilot-tunnel, as described fully in my Patent No. 713,519, dated November 11, 1902.

In the figures, *b* is the material to be tunneled; *a*, the frozen material; *c*, the heading or apex of the excavation.

1 is the heading of the tunnel, sometimes called the "working" or preferably the "freezing" chamber; 2, a shield, such as is usually used for excavating and tunneling, modified so as to suit the peculiar conditions; 3, the cutting edges of the shield; 4, the walls of the completed tunnel-lining; 5, hydraulic or other jacks; 6, the orifice of the tube from which the freezing medium is directed against the apex; 7, the main pipe conveying the medium of cold through completed tunnel; 8, the flexible pipe or hose connecting 7 with the pipe 11, passing through the shield.

9 is the main pipe carrying off or exhausting the cold air or other medium of cold after it has accomplished its function of freezing.

10 is a hose or other flexible connection between 9 and the permanent pipe 12 in the shield.

In previous methods of submarine excavation where compressed air, a shield, or freezing alone have been employed there have been the difficulties of expense, injury to workmen, and danger of collapse. My new invention guards against this latter danger, and prevents serious delay and injury to the tunnel itself should the collapse occur, as will be hereinafter explained.

In my Patent No. 417,288 I show a method of tunneling which provides for keeping the heading in a conical or approximately conical shape, and I have indicated the possible use at the apex of a small pipe to accomplish the freezing in advance of the apex. In my Patent No. 713,519 I have indicated a method of tunneling which contemplates the driving first of a pilot-tunnel by any means and using this as a refrigeration-chamber from which to solidify by freezing the surrounding material. These methods contemplate the presence in the chamber where the freezing is going on of men to do the excavating of the frozen material. These men would be subject to the danger of the collapse of the frozen wall in case they should excavate too near the limits of the same, so that it would become dangerously thin.

In this invention, broadly speaking, I construct a freezing-chamber and introduce freezing agents at the extreme advanced part, excavating as fast as the thickness of the frozen shell permits with safety. In so doing I may construct my freezing-chamber of a conical or substantially conical shape, gradually and successively freezing and excavating from apex to rear until I have attained the required diameter, or I may start a pilot-tunnel and freeze steadily until I have attained the required thickness of frozen shell and then excavate to the required diameter, or I may employ any suitable method utilizing a freezing-chamber in advance of the main tunnel. As soon as the excavation has attained the desired diam-

eter I introduce an air or water tight shield 2, which may be of any suitable form and provided as usual with passages or air-locks. (Not herein shown to avoid complicating the drawings.) This shield may be provided with cutting edges 3, as usual, and is advanced by any well-known means, as by hydraulic jacks 5. The particular construction of the shield itself not forming a part of this invention is not further particularly described. A pipe 7 is laid, preferably, to the point near the rear of the shield, where it may be connected, by means of a flexible or movable device, such as a hose 8, to the pipe 11, passing through the shield. This pipe carries a freezing medium, such as very cold air or other freezing medium, which is preferably directed at the apex or heading *c* of the freezing-chamber 1. Thence flowing back through this chamber it reduces the temperature therein to such a degree that the material adjacent is frozen and may then be excavated in various ways that are well known in the art. The freezing medium is then or is continuously during the freezing exhausted through 12 10 9, in which 10 is a flexible connection, as already described. If the freezing medium is a liquid, as brine, ammonia, &c., it is of course not permitted to issue from the pipe 11 into the chamber 1, but is circulated, as is well understood, in a suitable manner in the pipes constituting the freezing system. The shield 2 is advanced in accordance with the progress of the freezing and work of excavation, and in addition to its other functions may be either used as a retreat or barrier in case of collapse of the frozen wall, or other leakage or as a barrier to confine the cold to the freezing-chamber, or it may be utilized in the usual way as a means of excavation with or without compressed air, and as a bracing-wall to withstand any tendency of the frozen wall to collapse.

It is sometimes desired to apply an unusual amount of cold to the freezing-chamber and to maintain a pneumatic pressure to help resist the tendency to collapse, in which case it has been found advantageous to increase the density of the air in the chamber, the freezing being more affective and rapid in a dense atmosphere. This of course requires a higher pressure than normal, and the pressure can be obtained by compressing the freezing medium itself when gaseous, and it should be noted that both the temperature and the pressure of the freezing medium can be regulated at will. If an accident occurs and the frozen shell of the freezing-chamber collapses in whole or in part or any similar danger arises, the men working in the chamber can pass through the shield, closing the doors, and then the operation may be continued without serious interruption, by the shield and compressed-air methods, and the recongealing of the surrounding material continued. Moreover, it is of advantage to operate the shield as a guide

and form for the tunnel-lining which succeeds it, in connection with the freezing-chamber, and the cutting edges materially assist and coöperate in the alinement, and in the excavation of the frozen shell of the freezing-chamber. Moreover, I sometimes prefer to place and advance my shield within the tunnel-lining, constructing the latter outside of the shield.

I wish it understood that I neither claim nor limit myself to a shield of any particular design or arrangement, since such features I consider details of construction of the shield, which may form the subject-matter of another application and do not affect this invention, which is of a process in performing which I utilize certain instrumentalities in coöperation and order, nor do I limit myself to any particular means or method of freezing or of excavating. I may freeze by circulating intensely cold air in contact with the exposed walls of the excavation, or I may confine liquid freezing agents in pipes, or otherwise near to, in contact with, or inserted in the walls, or I may utilize any other method of freezing. I may also excavate by thawing, boring, blasting, or any other desirable means. Moreover, I do not limit myself to a submarine tunnel nor to one lying in a horizontal plane; but

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

1. The method of tunneling which consists in constructing a freezing-chamber in the material to be excavated, freezing the surrounding material, advancing a shield in rear of the freezing-chamber, and completing the tunnel-lining, substantially as described.

2. The method of tunneling which consists in progressively freezing, excavating, advancing a shield, and constructing the tunnel, substantially as described.

3. The method of tunneling which consists in first freezing the ground; second, advancing a shield through the frozen material; third, completing the tunnel, substantially as described.

4. The method of excavating which consists in constructing a freezing-chamber in the material to be excavated, freezing the material, and advancing a shield, substantially as described.

5. The method of excavating which consists in progressively freezing the material to be excavated, and advancing a shield, substantially as described.

6. The method of excavating which consists in alternately freezing and excavating on increasing radii, and advancing a shield through the material.

7. The method of excavating which consists in making an excavation, progressively freezing the interior surface thereof, excavating from the rear, and advancing a protective obstruction of the tunnel at its mouth, the freez-

ing being continued where the frozen earth is removed, substantially as described.

8. The method of excavating which consists in making an excavation, then progressively
5 freezing the interior surface thereof, excavating a portion of the frozen material, and advancing a shield, substantially as described.

9. The method of excavating a tunnel which consists in progressively freezing and excavat-
10 ing the ground and advancing a protective obstruction at the mouth of the tunnel, substantially as described.

10. The method of freezing the ground which consists in introducing a freezing medium un-
15 der pressure into a closed chamber in the material to be excavated, substantially as described.

11. The method of excavating which consists

in constructing a closed chamber in the material to be excavated, introducing therein a
20 freezing medium under pressure, and excavating the frozen material, substantially as described.

12. The method of erecting a subterranean structure which consists in constructing a
25 closed chamber in the ground, introducing therein a freezing medium under pressure, excavating the frozen material, and constructing the structure, substantially as described.

Signed at New York, in the county of New
York and State of New York, this 22d day of
January, A. D. 1904.

CHARLES SOOYSMITH.

Witnesses:

JOSEPH S. RALNIK,
W. S. THOMSON.