No. 736,308. PATENTED AUG. 11, 1903.

C. SOOYSMITH.

METHOD OF FREEZING THE GROUND.

APPLICATION FILED DEC. 3, 1902.

NO MODEL. 4 SHEETS—SHEET 1.

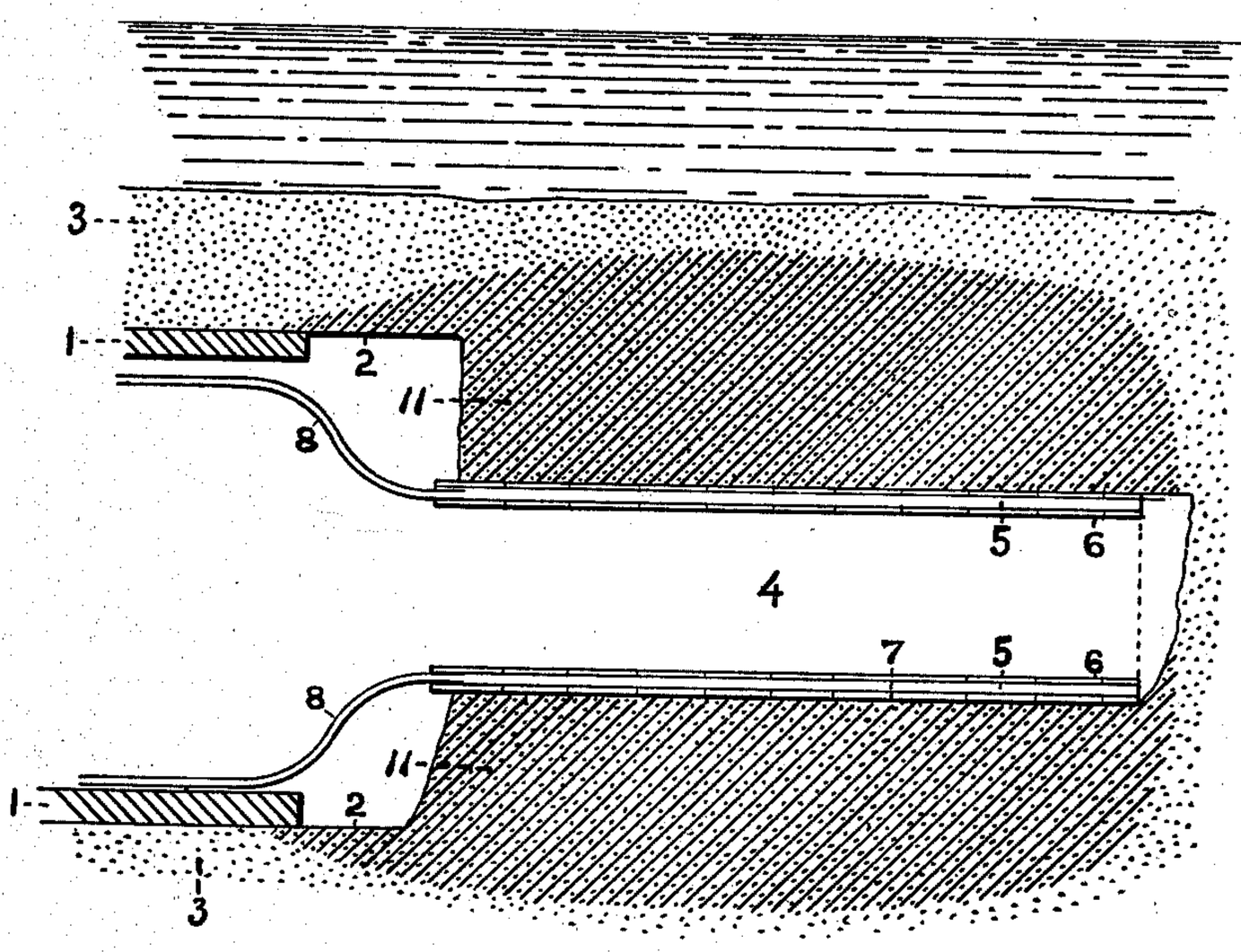

Fig. 1.

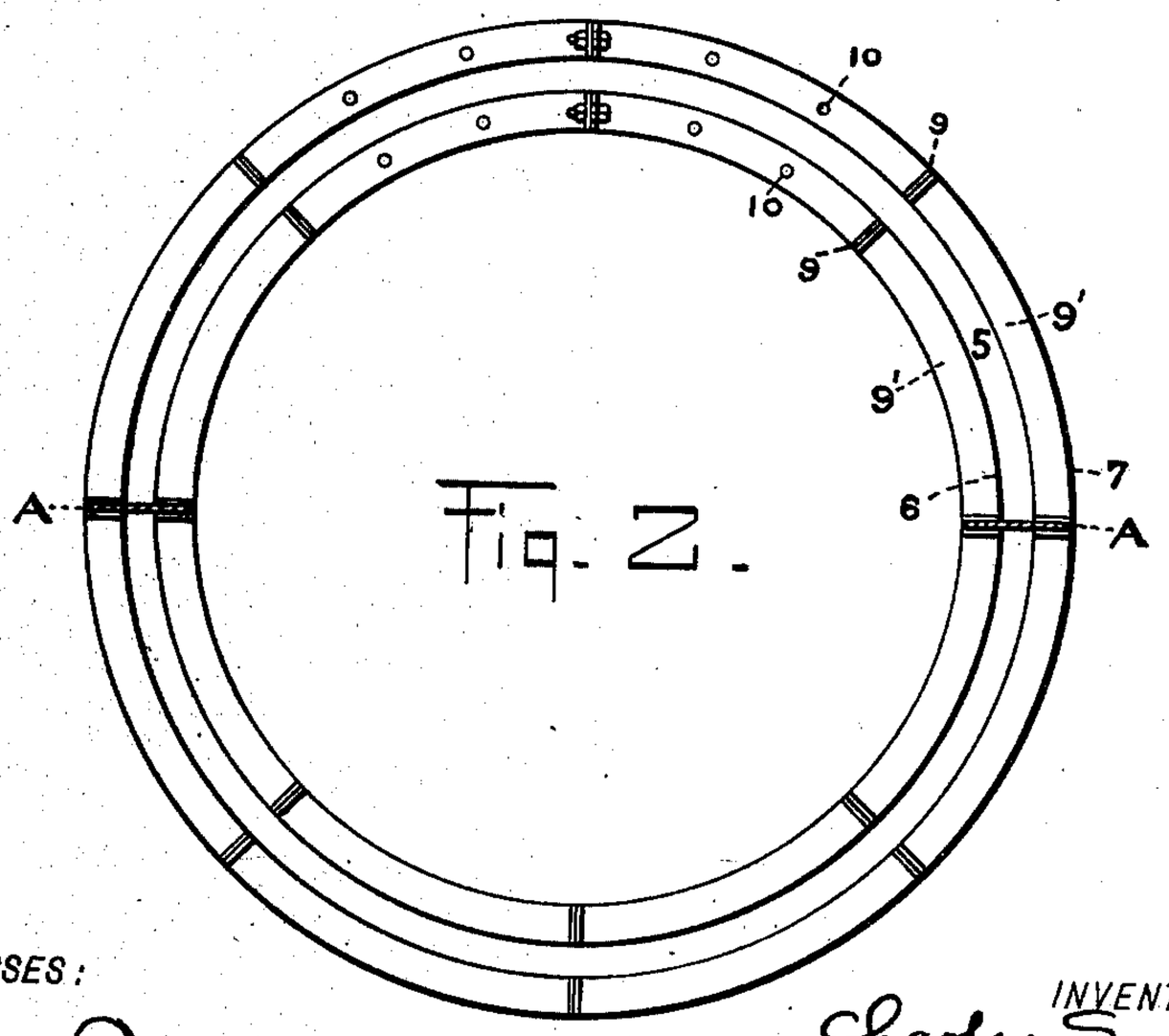

Fig. 2.

WITNESSES:

Susan Engelbaum

Louis Hicks

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NO MODEL. 4 SHEETS—SHEET 2.

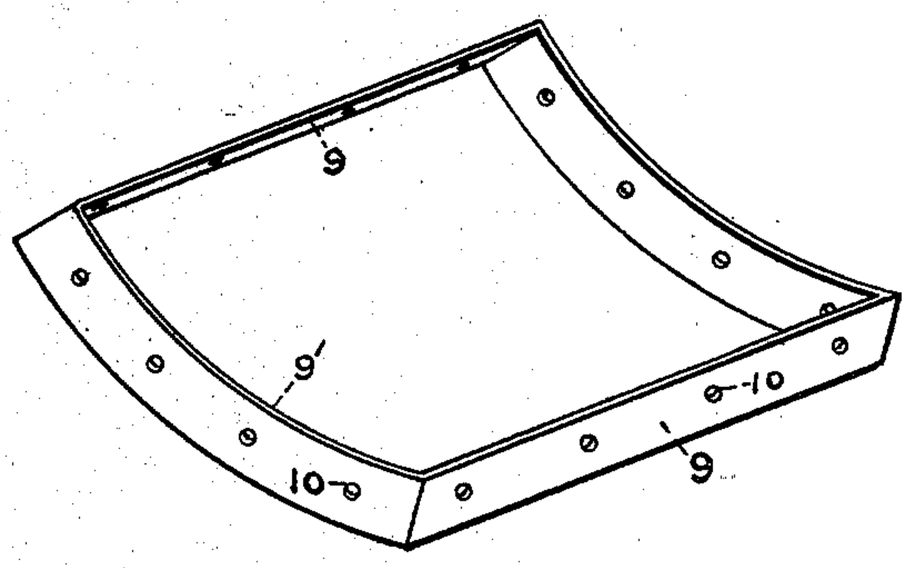

Fig. 3.

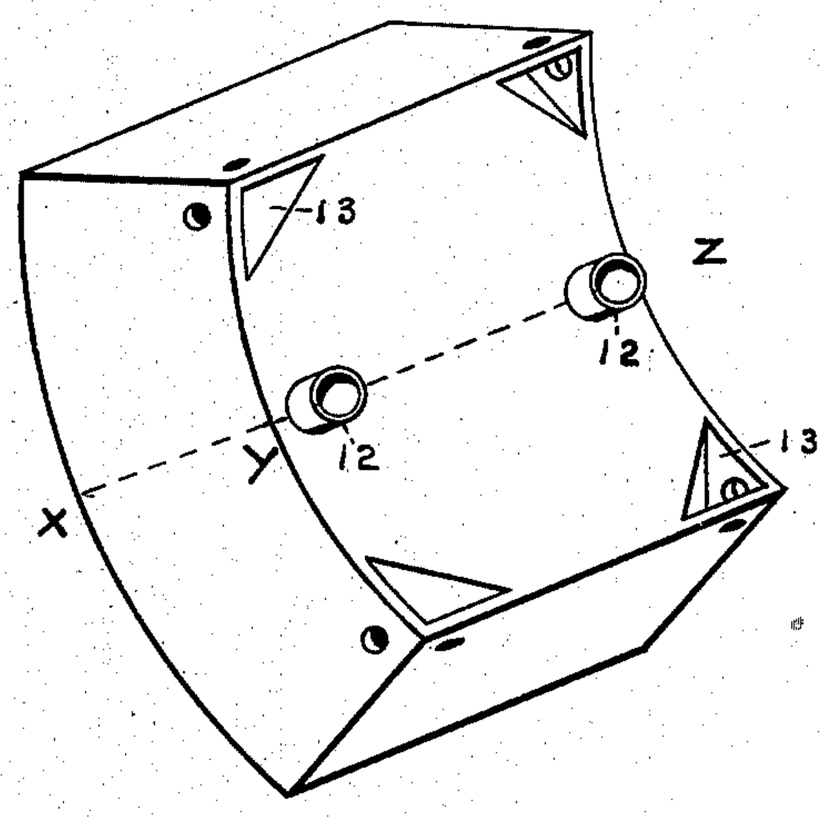

Fig. 4.

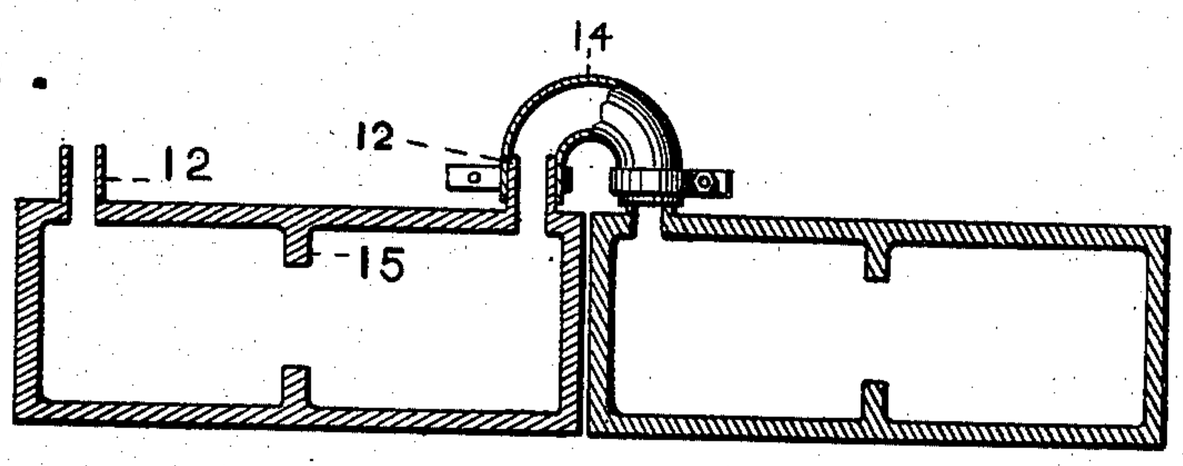

Fig. 5.

WITNESSES:

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No. 736,308. PATENTED AUG. 11, 1903.

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NO MODEL. 4 SHEETS—SHEET 3.

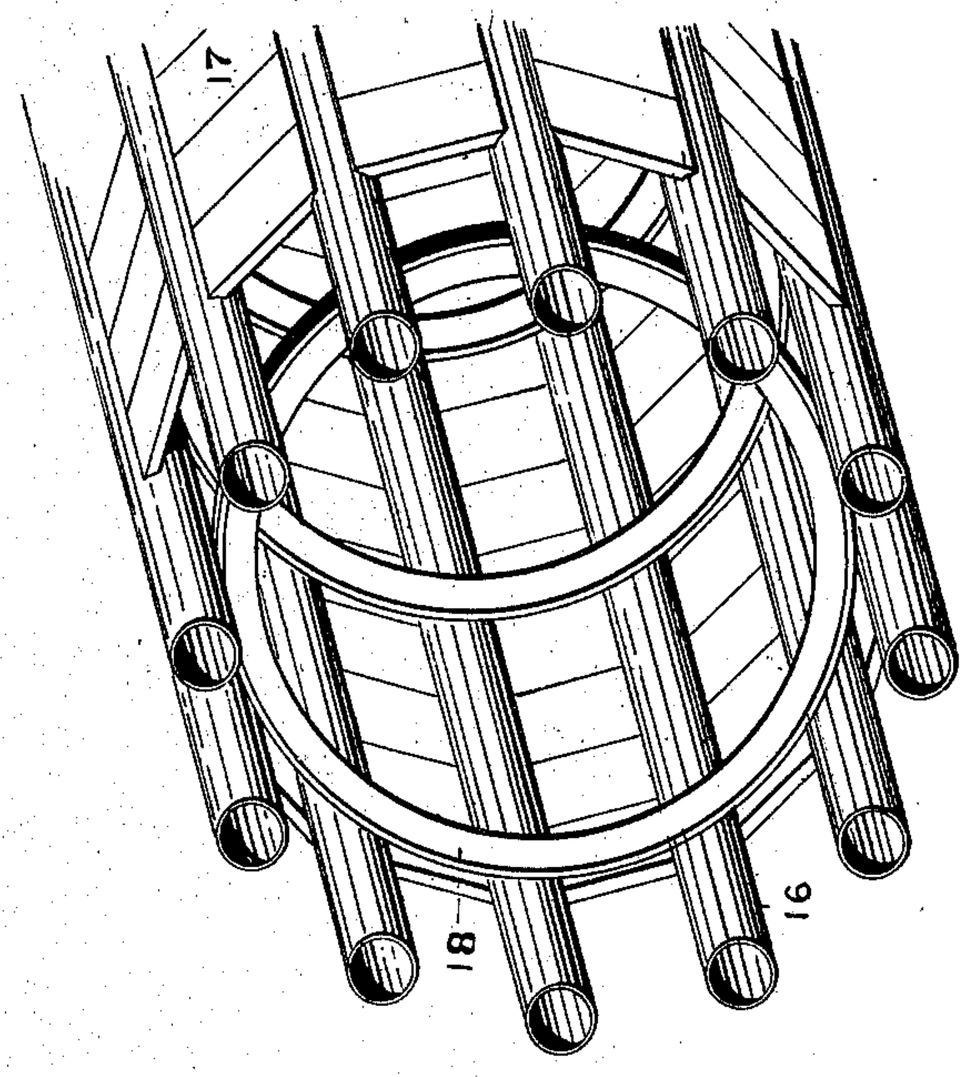

Fig. 6.

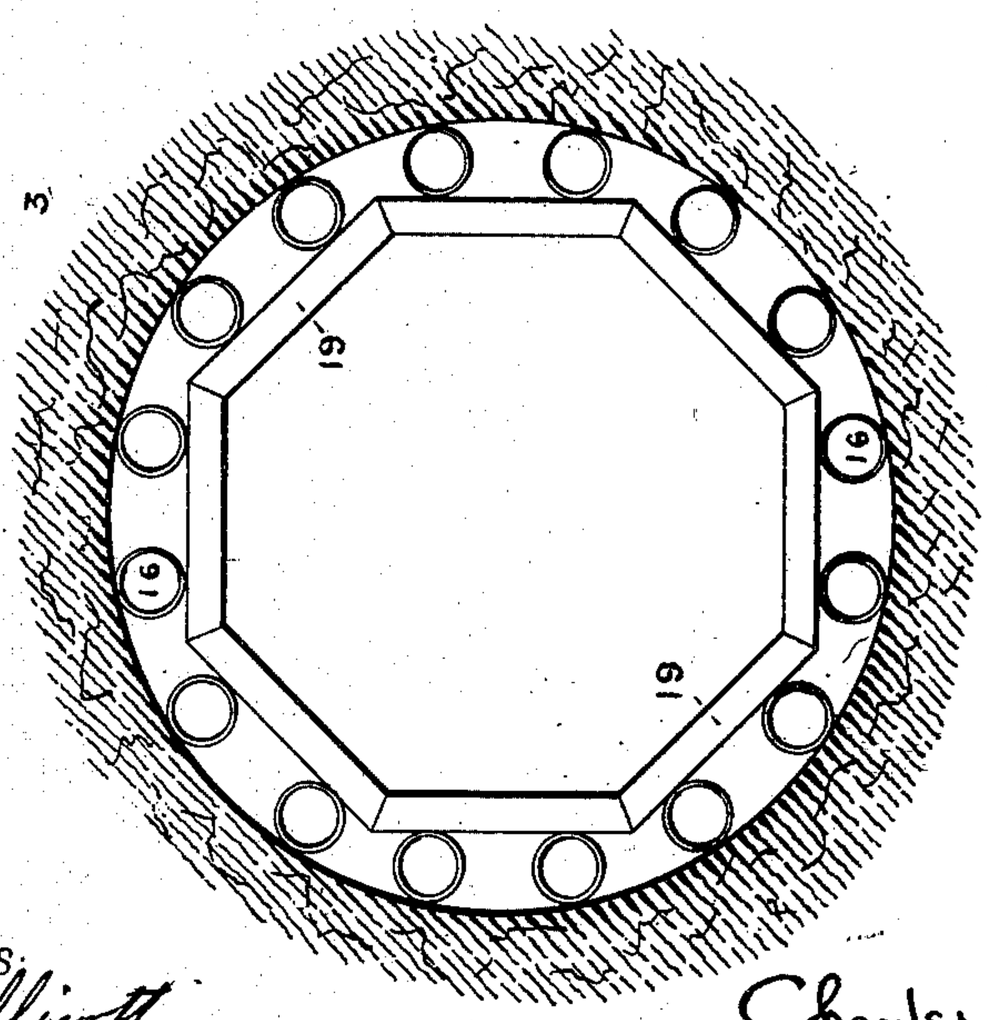

Fig. 7.

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No. 736,308. PATENTED AUG. 11, 1903.

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METHOD OF FREEZING THE GROUND.

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NO MODEL. 4 SHEETS—SHEET 4.

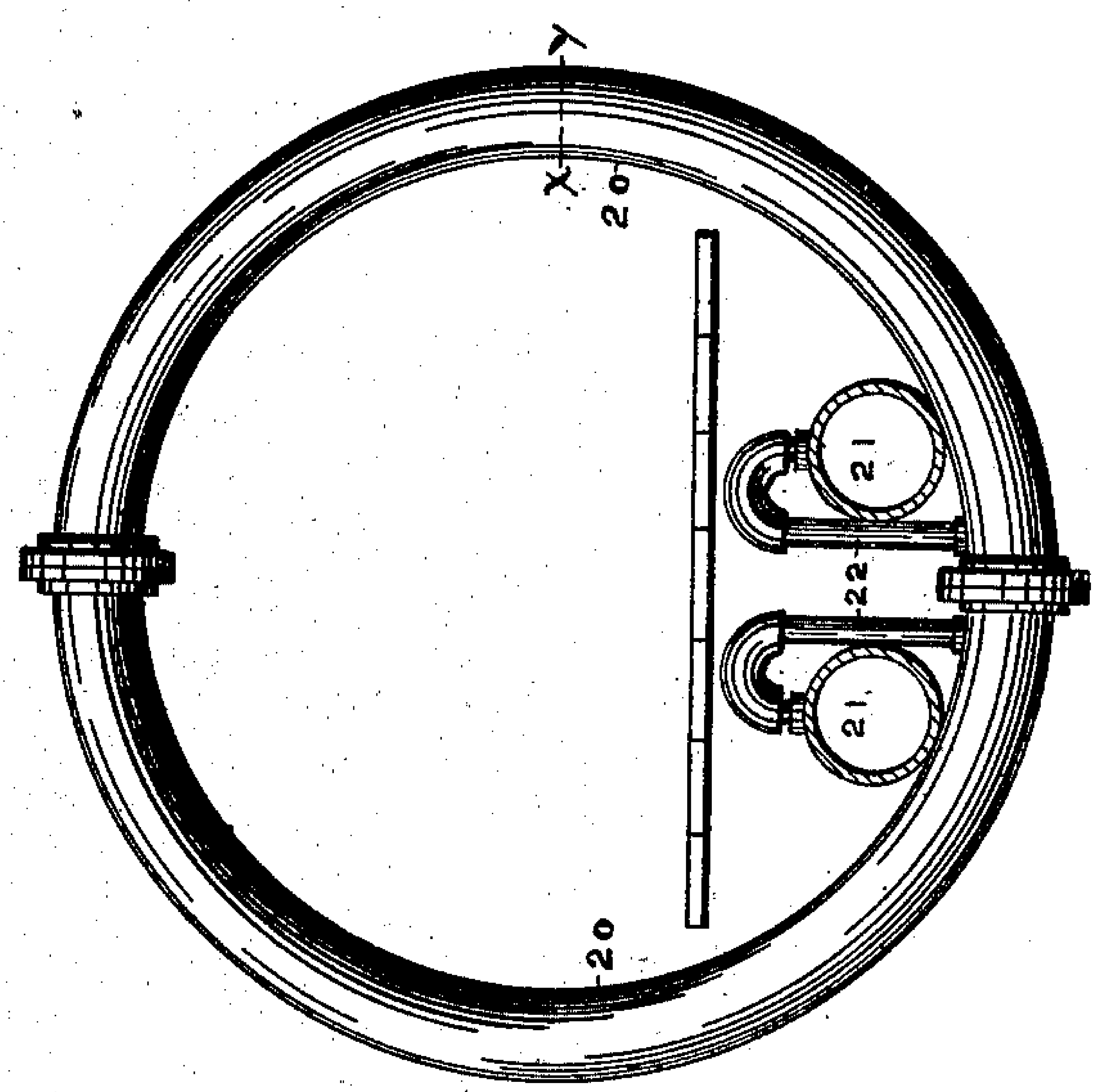

Fig. 9.

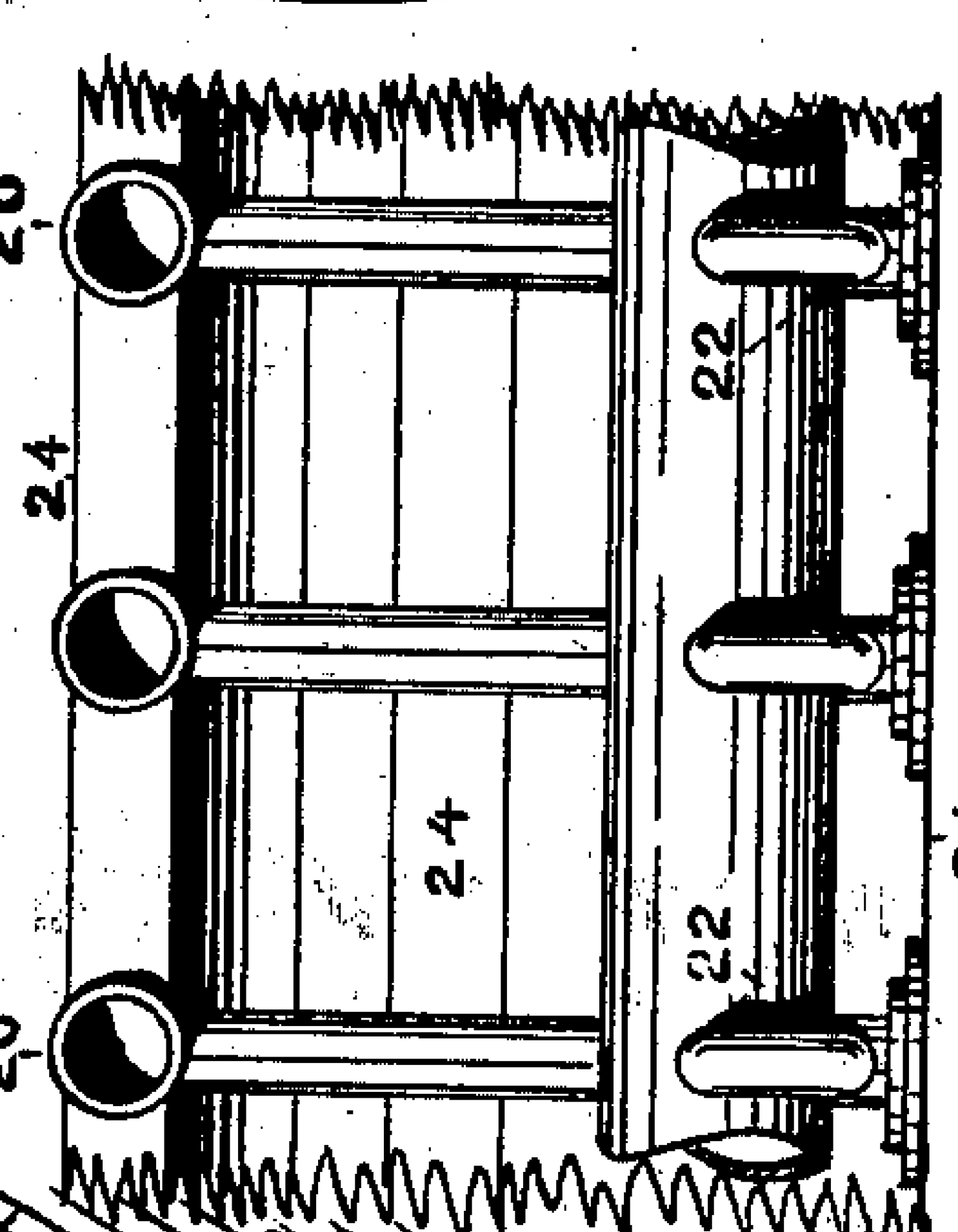

Fig. 10.

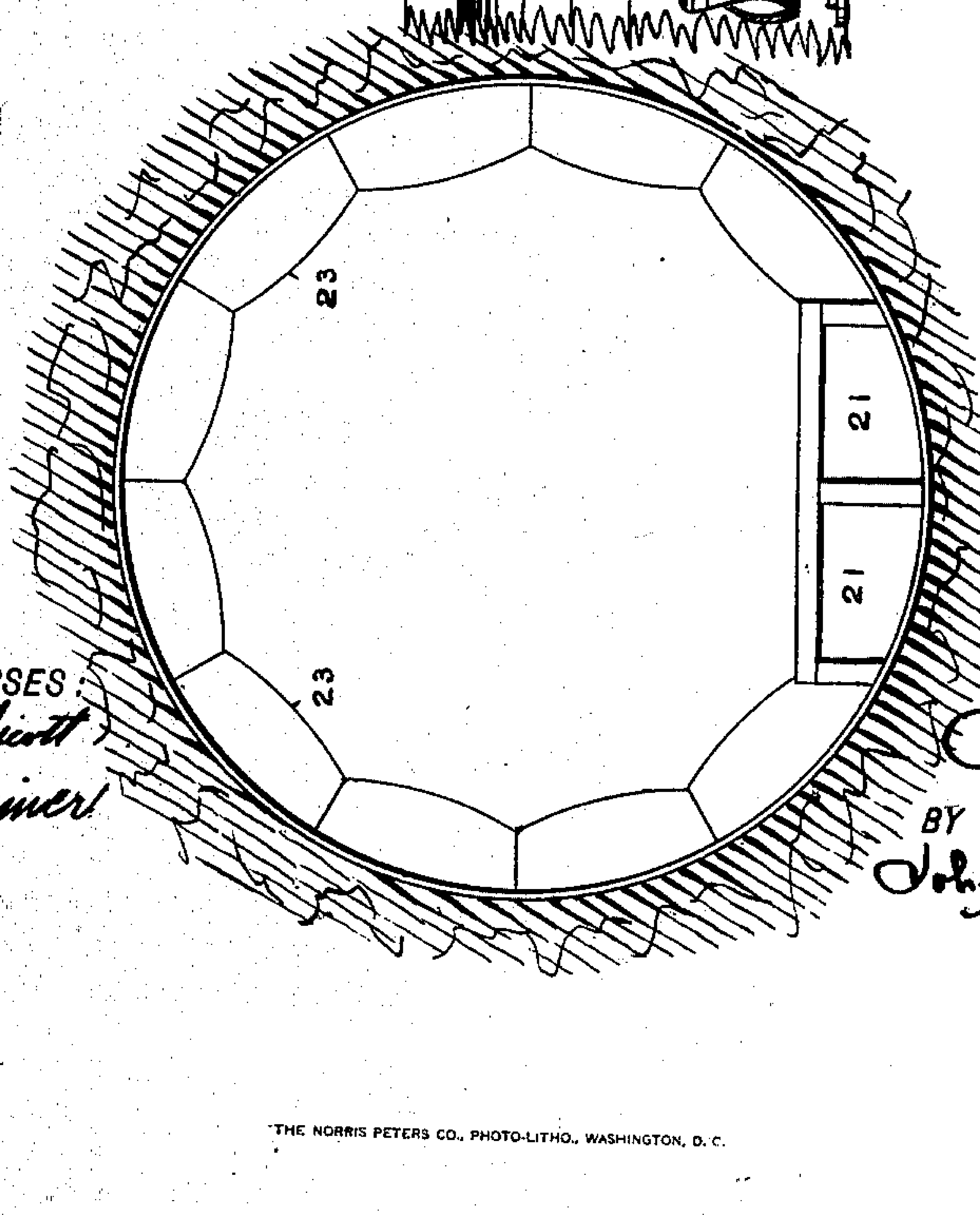

Fig. 8.

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John W. Loveland.
ATTORNEY

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 736,308. Patented August 11, 1903.

UNITED STATES PATENT OFFICE.

CHARLES SOOYSMITH, OF NEW YORK, N. Y.

METHOD OF FREEZING THE GROUND.

SPECIFICATION forming part of Letters Patent No. 736,308, dated August 11, 1903.

Application filed December 3, 1902. Serial No. 133,722. (No specimens.)

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 Freezing the Ground, of which the following is a specification.

My invention relates to the process of freezing the ground preparatory to and as a part of the processes of excavation and construction of underground and submarine tunnels, shafts, or other similar devices, and especially when employed in soft or yielding or water-bearing materials—as in the yielding mud, ooze, quicksand, or other unstable bed of a river or like situation.

The object of my invention is to provide an economical, easy, expeditious, safe, and convenient as well as practical method of freezing or solidifying the material surrounding or adjoining that which is to be excavated in such a way, to such an extent, and in such relation as to present a firm barrier or obstacle to the inflow of the soft, plastic material or the liquid contained therein to the excavation as the work proceeds.

My object is also to provide such a method of and means for accomplishing this function that it will not interfere with the simultaneous advance and performance of the processes preliminary to the main work of excavating and the freezing itself—as, for instance, the testing the temperature and the extent or thickness of the frozen wall, making repairs, removing material, permitting inspection, &c.

I attain these objects by the use of the processes and the means illustrated in the accompanying drawings, described in the following specification, and claimed hereinafter.

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

Figure 1 is a longitudinal sectional elevation of one form of device employed in applying my method to the freezing of soft soil in advance, for instance, of a tunnel. Fig. 2 is an end elevation, also in section. Fig. 3 is a perspective of one of the elements. Fig. 4 is a perspective showing hollow elements adapted to be secured together and forming the hollow shell of the pilot-tunnel. Fig. 5 is a sectional view on the line X Y Z, Fig. 3, showing pipes or hose connection between the elements. Fig. 6 is a view in perspective showing a modification of my invention. Figs. 7 and 8 are cross-sectional elevations showing still different arrangement. Fig. 9 is an end elevation showing a construction in which pipes form the arch or frame of the pilot-tunnel or chamber. Fig. 10 is a plan, partly in section, in plane X Y.

In my Patent No. 713,519, issued November 11, 1902, for a method of building tunnels, &c., I have described my method of constructing a pilot-tunnel in advance of the main tunnel and freezing the surrounding material by means of devices contained within the pilot-tunnel or the circulation of freezing agents within the same, and in my Patent No. 711,012, issued October 14, 1902, for a method of excavating and constructing tunnels I have described the construction of a plurality of pilot-tunnels by which I avoid the difficulty caused by the possible obstruction of one or two of the pilot-tunnels by the freezing apparatus when that is contained in the interior space of the pilot-tunnel. I have not, however, heretofore, and so far as I know no one else has heretofore, shown or devised a method of freezing the material surrounding the pilot-tunnel except by an agent or apparatus contained in the pilot-tunnel itself. While the latter method is entirely practicable and in many cases desirable, it is often to be preferred that the interior of the pilot-tunnel be entirely unobstructed for convenience of access and egress in excavating and removing the material from the heading for making repairs or test borings, &c. I therefore have devised the plan of making the walls of my pilot-tunnel hollow in whole or in part and circulating within said walls my freezing agent or "vehicle of cold," by which expression I include any freezing agent—as brine, cold air, ammonia, or any other substance or agent by which the freezing effect is produced—my invention not lying in the agent but in the method of and means for permitting the effect of that agent to be produced on the surrounding material. It is obvious that there are many ways in which I may construct the walls of the pilot-tunnel

to further this end. I may use parallel pipes longitudinally arranged, so as to form alone or in combination with other material the walls of the same. I may arrange parallel pipes curved so as to form the wall and lying in planes perpendicular to the axis of the tunnel and either closely spaced or with intervening spaces filled in with other material. I may utilize metal or other hollow sections bolted together and connected by pipes or of such shapes as to form by themselves the wall, as will be more fully described hereinafter, and other ways.

Referring to the figures, in Fig. 1, 1 is the lining of the completed tunnel; 2 is the final line of excavation of the frozen material before placing the lining; 3 is the surrounding mud, ooze, or quicksand; 4, the pilot-tunnel; 5, the space between the inside wall 6 and outside wall 7 of the pilot-tunnel lining, in which space the freezing agent is circulated; 8, the pipes leading to and away from this space and conveying the freezing agent; 11, the frozen soil.

In Fig. 2 A A are partitions separating the freezing-space 5 into two parts, one for the incoming and the other the outgoing freezing agent. 9 9 are flanges by which sections may be bolted together, 10 being bolt-holes.

Referring to Fig. 4, 12 12 are the nipples to which the connecting hose or pipe 14, Fig. 5, is clamped. 13 13 are pockets in the casting to permit the screwing up of connecting bolts and nuts.

Referring to Fig. 5, 14 represents connecting hose or pipe. 15 is a stiffening-rib to strengthen the casting.

Referring to Fig. 6, 16 16 are parallel longitudinal pipes containing a freezing agent in circulation and forming the wall of the pilot-tunnel in combination with boards or like material 17, the whole supported by and resting upon frames or ribs 18, which may be steel angle-bars.

Referring to Fig. 7, 19 19 are timbers forming the main shell of the pilot-tunnel, outside of which the pipes 16 are placed and against which hydraulic jacks used in advancing the shield may be operated.

Referring to Fig. 8, 23 23 is a temporary inside lining or partition or interior wall which I may employ instead of making the tunnel-lining hollow or employing pipes, the function being the same—*i. e.*, the confining the freezing agent to the perimeter or wall of the pilot-tunnel. This temporary lining may be made of canvas or boards or other material and of any shape and secured in position by any effective means which result in providing a passage for the freezing agent and confining the latter to the outside wall or lining of the pilot-tunnel.

Referring to Fig. 9, 20 20 are curved pipes forming the frame of the pilot-tunnel and spaced as required, the spacing being filled in with planking or other suitable material to exclude the soil or leakage. These pipes lie in parallel planes and perpendicular to the axis of the pilot-tunnel. 21 21 are the conduits for the freezing agent.

In Fig. 10, 24 24 is the brick or wood filling between pipes.

I wish it to be understood that the devices here shown are only a few of many practical means, to which I do not strictly confine myself. For example, I may employ a continuous pipe extending in a spiral along the perimeter of the freezing-chamber, as the exact shape, location, proportion, and arrangement of the parts may be varied or departed from without departing from the essential features of my invention, the operation of which is as follows: Where it is desired to freeze or solidify the ground, as in a mine, in the construction of a tunnel, or under any circumstances, I construct a chamber or pilot-tunnel in the approximate center of the spot to be frozen. For the purpose of explaining my method herein I have chosen the construction of a tunnel as most clearly illustrating it. After advancing the excavation of my "freezing-chamber," as I will hereinafter call it, a sufficient distance I place the lining, which is sometimes constructed of two portions 6 and 7, consisting of flanged sections adapted to be secured together and separated by suitable means, so as to leave an annular space between the same for the freezing agent. The partition A assists at once to support the inside lining and serves to separate the incoming and outgoing currents of the freezing agent. I sometimes construct the lining of hollow sections adapted to be self-supporting by their shape or to be secured together and provided with communicating ducts, whereby there is uninterrupted passage for liquids, gas, or similar medium from one to the other. (See Figs. 4 and 5.) The lining may be constructed of parallel pipes 16, supported on rings or ribs or frames 18 19, and so connected that the freezing agent may be circulated through the series. These pipes preferably have material behind, in front of, or between to complete the lining and exclude the soft material or the water contained therein, as shown by 17 19 24 in Figs. 6 and 7. Where the pilot-tunnel is advanced by means of a shield, the hydraulic jacks or other means may be operated against these timbers or brick, which constitute a firm base or resistance.

I may form the tunnel-lining of pipes arranged in parallel planes perpendicular to the axis and suitably connected to the supply of the freezing agent, as 20, Fig. 9, and in such case I fill in between these pipes with timber, planking, brick, or other suitable material, as indicated in Fig. 10. As I have intimated, I may not construct my hollow lining of this permanent nature, but may instead insert a thin metal outside lining sufficient to exclude the surrounding material and then hang or place a temporary inside lining 23 as of wood or even canvas, sus-

tained at the proper distance from the outside lining, so as to leave a sufficient space for the circulation of the freezing medium between the two linings, thus confining it to this space and constituting, in effect, a complete hollow lining for the performance of this method.

It is to be understood that this invention is not confined to any particular purpose, as to tunneling, or to any particular direction, as the horizontal, nor to any particular location, as under water.

I make no claim herein to the apparatus or appliances here shown in themselves, as they are shown to more clearly illustrate the easiest and most practical means for carrying my method into effect and do not constitute my invention described herein, which is a method of freezing and may be carried out independently of any particular one of the devices here shown.

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

1. The method of freezing the soil which consists in, first, excavating therein a chamber of sufficient size to permit excavation from within; second, lining said excavation with hollow communicating sections; third, circulating a freezing agent in said sections, substantially as described.

2. The method of freezing the soil which consists in, first, excavating therein a chamber of sufficient size to work in, second, placing a plurality of hollow elements in the excavation in proximity to the soil leaving the interior space substantially unobstructed, third, circulating a freezing agent in said elements, substantially as described.

3. The method of freezing the soil which consists in, first, excavating therein a pilot-tunnel of sufficient size to work in, second, circulating a freezing agent in a confined space in contact with the walls thereof, third, extending the pilot-tunnel, fourth, continuing the freezing in the extended portion, substantially as described.

4. The method of freezing the soil which consists in, first, excavating therein a freezing-chamber, second, constructing a cellular lining therein, third, circulating a freezing agent in said lining, substantially as described.

5. The method of freezing the soil which consists in, first, excavating therein a chamber, second, constructing a hollow lining to the chamber, third, circulating a freezing agent in said hollow lining, substantially as described.

6. The method of freezing the soil which consists in, first, excavating therein a chamber, second, erecting a partition substantially parallel to the outside wall of the chamber, third, circulating in the space between the partition and the outside wall a freezing agent, substantially as described.

7. The method of freezing the soil, which consists in, first, excavating therein a chamber, second, circulating a freezing agent in a confined space located in proximity to the interior surface of the excavation, substantially as described.

8. The method of freezing the soil which consists in, first, excavating therein a freezing-chamber, second, constructing a lining to the said chamber with an annular space within its walls, third, circulating a freezing agent in said annular space, substantially as described.

9. The method of freezing the soil which consists in, first, excavating therein a freezing-chamber, second, providing said chamber with hollow walls, third, circulating a freezing agent in said walls, fourth, extending the freezing-chamber, fifth, continuing the freezing in the extended portion, substantially as described.

10. The method of freezing the soil which consists in, first, excavating a freezing-chamber therein, second, constructing a lining with double walls, third, introducing a freezing agent between said double walls at one part of said chamber and exhausting it from another, substantially as described.

11. The method of freezing the soil which consists in, first, constructing therein a freezing-chamber, second, applying a freezing agent to the interior surface of the said chamber through conduits located in proximity thereto, substantially as described.

12. The method of freezing the soil which consists in, first, excavating a chamber therein, second, separating a space adjacent to the soil, third, circulating the freezing agent in said space, substantially as described.

Signed at New York, in the county of New York and State of New York, this 29th day of November, A. D. 1902.

CHARLES SOOYSMITH.

Witnesses:
Z. ROSENFIELD,
A. GUNDERSHEIMER.