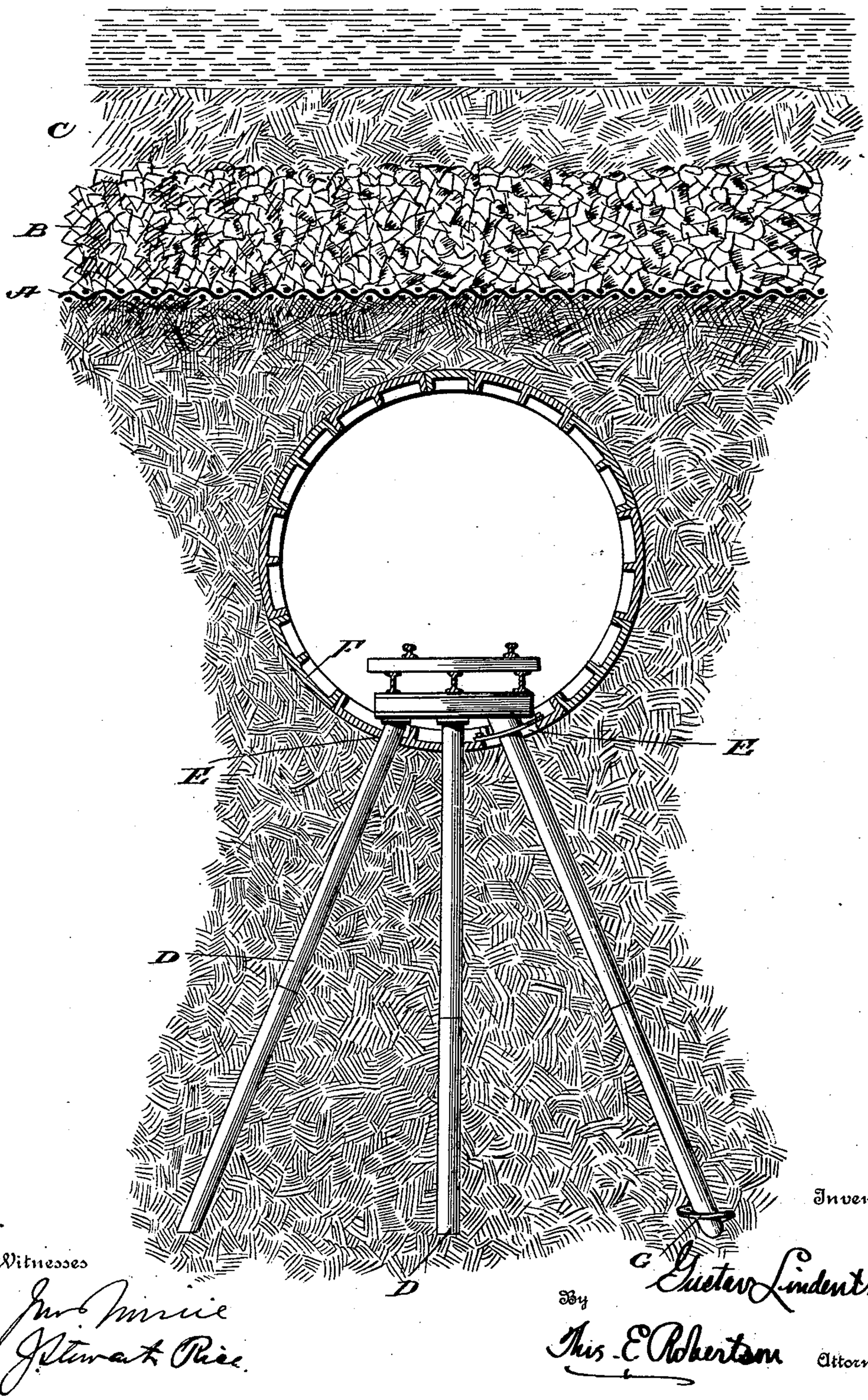
No. 714,205. Patented Nov. 25, 1902.

G. LINDENTHAL.

METHOD OF LAYING TUNNELS.

(Application filed Feb. 5, 1902.)

(No Model.)



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METHOD OF LAYING TUNNELS.

SPECIFICATION forming part of Letters Patent No. 714,205, dated November 25, 1902.

Application filed February 5, 1902. Serial No. 92,709. (No model.)

To all whom it may concern:

Be it known that I, GUSTAV LINDENTHAL, a citizen of the United States of America, 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 Laying Tunnels, of which the following is a specification.

This invention relates to an improvement in the art of constructing subaqueous tunnels, and more particularly to a method of treating the soil through which the tunnel passes. It is sometimes desirable to place a tunnel at a very small depth below the river-bottom, and when the river-bottom is soft or mud-like it is liable to "blow-outs," caused by the compressed air effecting an escape through openings in the "shield" and thence through the mud or soft material above the tunnel. These blow-outs are serious obstacles well known to those building tunnels, and as one example by which it has heretofore been proposed to prevent them I might mention the process of freezing the soft soil in the path of the tunnel, thus providing a solid body of earth through which the tunnel may be driven. My improved method of preventing these blow-outs and at the same time overcoming the tendency of the tunnel to rise and float consists in forming an air-resisting medium or zone over the path of the tunnel, which is preferably done by employing an iron netting, a brush mattress of well-known construction, or any equivalent holding device, which is sunk on the soft river-bottom immediately over the path of the tunnel and weighted down in any desired manner, as by dumping riprap, stone, or any heavy material thereon. The holding device is preferably of a width several times that of the tunnel and of any suitable length. As a substitute for the riprap, &c., I can employ a platform or barge loaded with stone, pig-iron, &c., which can be sunk to the bottom of the river and act similarly to the riprap in weighting down the soil and condensing the same, so as to provide an air-resisting medium or zone to prevent or avoid the blow-outs.

My invention therefore consists in the method as hereinafter described and then definitely claimed.

The accompanying drawing illustrates a river-bottom treated by my method with the tunnel in position.

Referring now to the drawing, A represents an iron netting sunk to the bottom of the river immediately over the place where the tunnel is to be driven, where it at first lies on the soft river-bottom. After this iron-netting or holding device is placed in its proper position and before the tunnel is driven stone, riprap, or other heavy material B is dumped on it in sufficient quantities to cause the netting or holding device to compress the soft river-bottom and hold it in a more compact condition. In the drawing I have represented the stone as having caused the iron netting to sink through the upper layer of softest mud C and as settled somewhat, so that in its settled condition the earth under the iron netting is necessarily held in a very compact condition. Of course as the iron netting and its weighted material sink through the softest mud the interstices between the broken stone or other material become filled with the mud, which (as the stones settle) necessarily becomes very compact, and this layer of weighted material itself may act as an air-resisting medium or zone even if the mud underneath it should remain in a soft condition. The tunnel may now be driven without the usual tendency to blow-outs.

In place of the iron netting brush mattresses or any equivalent holding device may be substituted, and as a substitute for the riprap, &c., I may use suitable wooden or iron platforms or barges loaded with pig-iron or stone, which may be sunk to the bottom of the river.

In a separate application, executed of even date herewith, I have described and claimed a novel pile formation for tunnels, and the herein-described method of condensing the river-bottom prior to driving the tunnel is well adapted for driving tunnels in which said pile formation is used. This pile formation is represented by the piles D, which are illustrated as protruding through openings E in the casing of the tunnel F. These piles are of a length shorter than the diameter of the tunnel and inserted through the aforesaid openings E from the inside of the tunnel. The piles may be of the ordinary "screw"

character, as represented at G, in which case they are screwed into position, or they may be hollow iron piles, and by the application of a water-jet in the usual way (through a pipe centrally located) and by the use of hydraulic or other jacks resting on the tops of the piles and exerting pressure on the top of the tunnel the piles may be forced down to the desired depth. The piles may be spaced as closely as needed both lengthwise and crosswise of the tunnel; but I prefer that they should be driven into the soft river-bottom in the form of a regular pile formation, and while I have represented them as diverging they may be perpendicular. Of course when the piles are of a length greater than the length of the tunnel they may be spliced in the ordinary ways. After the piles are driven in position and suitably calked or made water-tight where they protrude through the sections of the tunnel-casing the tops of the piles may be dressed off to offer a suitable support for caps and beams, which in turn support the rails, or if intended for other than railway purposes an ordinary cement or concrete roadway may be substituted in lieu of the beams and tracks.

The pile formation and the weighted netting or other device are additional safeguards one for the other, as the heavy material not only acts as an air-resisting medium or zone to prevent blow-outs, but also aids in holding the tunnel in position to prevent it from floating up to the surface while the piles are being driven through the tunnel-bottom into the formation below. If the heavy material is in the form of loaded platforms or barges, the tunnel-tubes will be anchored in position while the piles are being driven, and thereafter the loaded platforms or barges may be floated and removed in order to be used for a new section of the tunnel.

When my method of laying or driving tunnels is used, I am enabled to drive a tunnel at a much smaller depth below the water than otherwise would be possible, and this of course results in lower grades at each end for the approaches, and thus necessarily provides shorter and more economical approaches.

What I claim as new is—

1. The improvement in the art of tunnel construction which consists in first producing above the path of the tunnel and prior to any boring operation thereunder an air-resisting zone, and in then driving the tunnel, substantially as described.

2. The improvement in the art of tunnel construction, which consists in weighting down the river-bottom and thereby forming an air-resisting medium or zone, and in then driving the tunnel, substantially as described.

3. The improvement in the art of constructing tunnels near a submerged surface of soft substance, which consists in first weighting and condensing a zone of said surface to prevent "blow-outs," and in then driving the tunnel through or under said zone, substantially as described.

4. The improvement in the art of tunnel construction, which consists in producing above the path of the tunnel an air-resisting medium or zone by sinking a holding device, loading the same with heavy material, and in driving the tunnel after said loaded holding device is in position, substantially as described.

5. The improvement in the art of tunnel construction, which consists in first producing above the path of the tunnel an air-resisting medium or zone, driving the tunnel-casing, and in then anchoring or supporting the tunnel, substantially as described.

6. The improvement in the art of tunnel construction, which consists in first condensing a zone of soft surface through or under which the tunnel is to be driven, then driving the tunnel, and in then supporting or anchoring the same, substantially as described.

Signed by me at 45 Cedar street, New York, this 22d day of January, 1902.

GUSTAV LINDENTHAL.

Witnesses:
M. B. SANFORD,
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