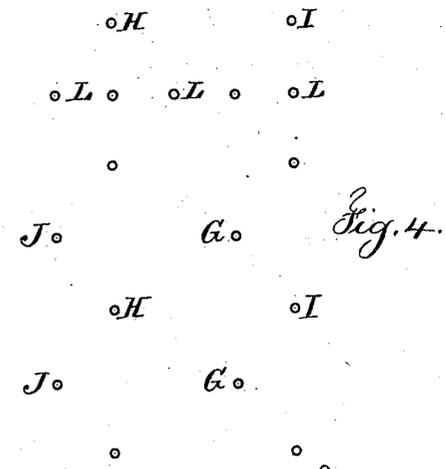
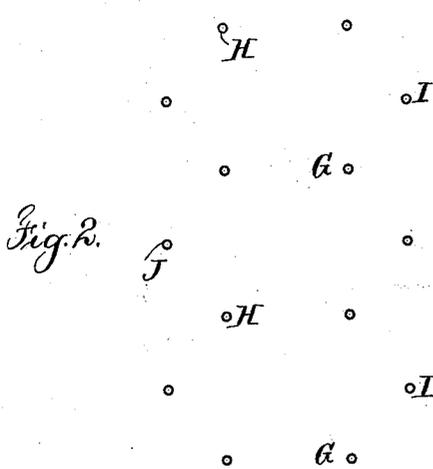
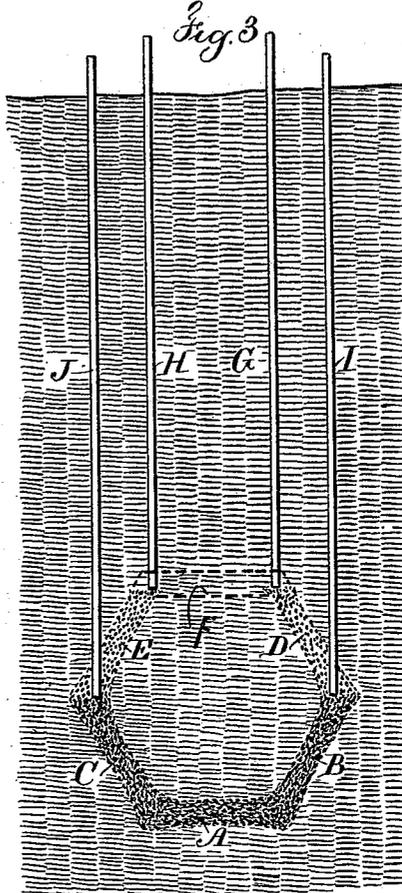
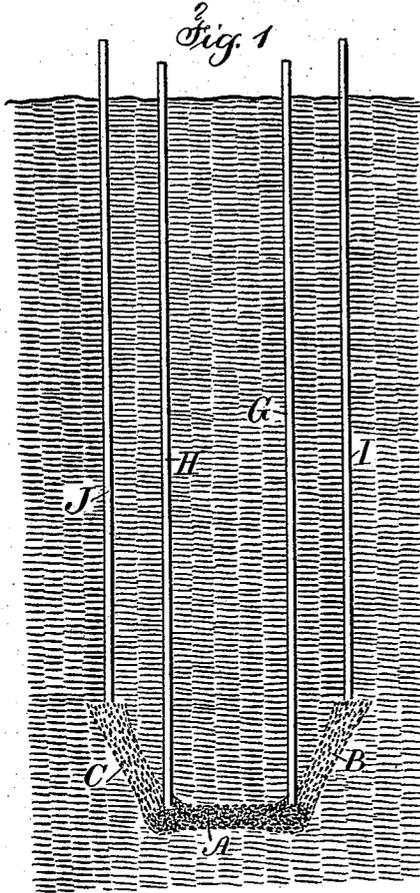


(No Model.)

R. L. HARRIS.
TUBULAR UNDERGROUND STRUCTURE.

No. 528,367.

Patented Oct. 30, 1894.



Witnesses
 Chas. H. Smith
 J. Staib

Inventor
 Robert L. Harris
 per Lemuel W. Serrell
 atty.

UNITED STATES PATENT OFFICE.

ROBERT L. HARRIS, OF NEW YORK, N. Y.

TUBULAR UNDERGROUND STRUCTURE.

SPECIFICATION forming part of Letters Patent No. 528,367, dated October 30, 1894.

Application filed February 9, 1894. Serial No. 499,584. (No model.)

To all whom it may concern:

Be it known that I, ROBERT L. HARRIS, a citizen of the United States, residing in the city, county, and State of New York, have invented an Improvement in Tubular Underground Structures, of which the following is a specification.

In Letters Patent No. 435,142, granted to me August 26, 1890, a means is set forth for introducing cement among loose materials for the purpose of strengthening or constructing foundations for piers and other structures, and in Letters Patent No. 464,771, granted to me December 9, 1891, a method of and means for constructing foundations or inclosures for buildings or other structures are set forth. In both of these patents adhesive material such as cement is introduced through tubes and by the same directed toward the place where the cement is to be lodged and allowed to harden, and in Patent No. 464,771 a method is described for opening up a channel or way between the end of one pipe or pipes and the end of another pipe or pipes before the introduction of the cementing material.

In the present invention I employ a mode of operation corresponding generally to that set forth in the aforesaid patents but proceed in such a manner as to form a tubular or substantially tubular structure in the sand or other material beneath the surface of the ground or below the bottom of a river, bay or other water-course, so that the tubular structure produced in the earthy materials can be opened or bored out after the cement hardens, and such cement will support the pressure of the earth or other materials above or around the tubular structure, and the cement and earthy materials may be used to form the tubular structure, or a lining of brickwork or other suitable material may be applied within the tubular structure after it has been bored out or excavated; and I provide for separating the structure into sections so as to keep out water or fine material where the structure is beneath the water and to allow for excavating one tubular section while the cementing materials of another section are hardening. In all instances such tubular structure is produced progressively by the cementing material introduced through

pipes from the surface or above the ground or water.

In wet or troublesome earthy materials a large portion of the expense of making sewers or tunnels when excavated from the surface, is for the side sheeting or protection and for the excavation of the materials above the proposed structure and the filling in above the structure.

By my present improvement a large portion of expense of sewers, tunnels and similar tubular structures is saved by dispensing with the excavation and the sheeting or protection for the same and the returning of the material above the tubular structure; and where the material is troublesome and treacherous, such as in quicksands, the risk of caving in is entirely prevented or reduced to a minimum and the cemented structure which is formed in the earthy material before any portion is disturbed or removed increases the strength of the permanent structure which may be made within the tubular excavation.

In the drawings, Figure 1 is a vertical section illustrative of the mode of commencing the structure within the earthy materials. Fig. 2 is a plan illustrating the places where tubes are to be inserted downwardly from the surface of the earth. Fig. 3 is a section similar to Fig. 1 illustrative of the manner in which the upper portion of the tubular structure is made. Fig. 4 is a plan indicating the position of the tubes in relation to such structure.

The series of pipes G H are to be driven from the surface so that their lower ends are near the grade of the bottom of the tunnel or other tubular structure, and through these pipes or rows of pipes G and H cementing material is inserted so as to form a floor A either by accretion, as set forth in my Patent No. 435,142, or channels or chambers may be opened up between the ends of the pipes previous to the insertion of the cementing material, as set forth in my Patent No. 464,771, and the cementing material is to be so introduced that the cement from one pipe will reach and commingle with the cement from another pipe so as to produce within the earthy materials the floor A which is to be of sufficient thickness to withstand the pressure and to obtain

the desired strength. The pipes G H are now to be drawn up sufficiently to clear their lower ends from the previously introduced cementing material.

5 The ranges of pipes I J are to be introduced at the proper distances from the pipes G H and with their lower ends at the proper level for introducing cement to form with the cementing materials introduced through the
10 pipes G H the inclined sides B and C in substantially the same manner as the floor A, the mode of procedure depending upon the character of the soil within which the structure is to be made, and in so doing either of
15 the modes of operation set forth in my aforesaid patents may be made use of, and these planes or sides B and C are to be of the proper thickness and strength.

20 The pipes G and H are to be drawn up to the desired elevation for forming the top portions of the desired tubular structure, and the operations heretofore described are to be repeated for producing the inclined planes or
25 sides D and E between the respective ranges of pipes I G and H J, and then a roof or top F is constructed in the manner similar to the floor A, by introducing cement between the pipes in the respective ranges of pipes G and
30 H, as illustrated in Figs. 3 and 4. The ranges of pipes may now be withdrawn and the earthy materials that are cemented together by the cement that is introduced as aforesaid are
35 allowed to remain until the cementing material properly hardens; and it is to be understood that the before described operations are to be extended along the route of the tunnel, sewer or other tubular underground structure, and the cement shell is made within the
40 one section being firmly united to the next when the cement structure is completed.

In structures that are beneath the water it is generally desirable to separate the tubular shell by transverse bulkheads. This is effected by cementing material introduced
45 through pipes arranged in a plane or group transversely of the tubular tunnel or sewer, as shown at L, the cement being inserted in either or both of the modes before described.
50 After the cement structure or shell has sufficiently hardened, the interior thereof can be excavated or bored out in any suitable manner and the material removed either at the end of the tunnel or through man-holes or
55 shafts at suitable distances apart, and the sewer or tunnel may be lined with brickwork, metal plates or any other permanent structure, and the bulkheads made as aforesaid serve to divide up the cement shell or
60 structure into sections that facilitate the construction, and should any one section be found weak or defective, the section or tunnel can

be flooded while the defect is remedied or the weak place strengthened in any suitable manner, such as by the introduction of cementing material.

The shape of the structure may be varied as desired. It may be triangular, polygonal, circular or elliptical, and where it is desired to construct a solid foundation, this may be
70 made therein after the tubular cement shell has been excavated.

This plan of making an underground shell offers a great advantage in treacherous ground or beneath bodies of water or in cities
75 beneath streets or buildings. I do not therefore limit myself to any particular occasion upon which the present improvements may be employed.

I claim as my invention—

80 1. The method herein specified of forming tubular underground structures, consisting in forcing down pipes from the surface to near the level of the lower portion of the structure, introducing cementing materials
85 through such tubes to cause the earthy materials to adhere together, introducing other ranges of pipes with their lower ends at a higher level and continuing the formation of the cement shell between the respective
90 ranges of pipes and drawing up one range of pipes to a higher level, introducing cement through the respective pipes for the formation of the upper portion of the tubular structure, and excavating such tubular structure
95 after the cementing materials have hardened, substantially as set forth.

2. The method herein specified of forming tubular underground structures, consisting
100 in forcing down pipes from the surface to near the level of the lower portion of the structure, introducing cementing materials through such tubes to cause the earthy materials to adhere together, introducing other
105 ranges of pipes with their lower ends at a higher level and continuing the formation of the cement shell between the respective ranges of pipes and drawing up the first range of pipes to a higher level, introducing
110 cement through the respective pipes for the formation of the upper portion of the tubular structure, introducing pipes and forcing in cementing material to divide up the tubular structure into sections by bulkheads or
115 partitions, and excavating such tubular structure after the cementing materials have hardened, substantially as set forth.

Signed by me this 6th day of February, 1894.

ROBERT L. HARRIS.

Witnesses:

GEO. T. PINCKNEY,
WILLIAM G. MOTT.