No. 742,222. PATENTED OCT. 27, 1903.

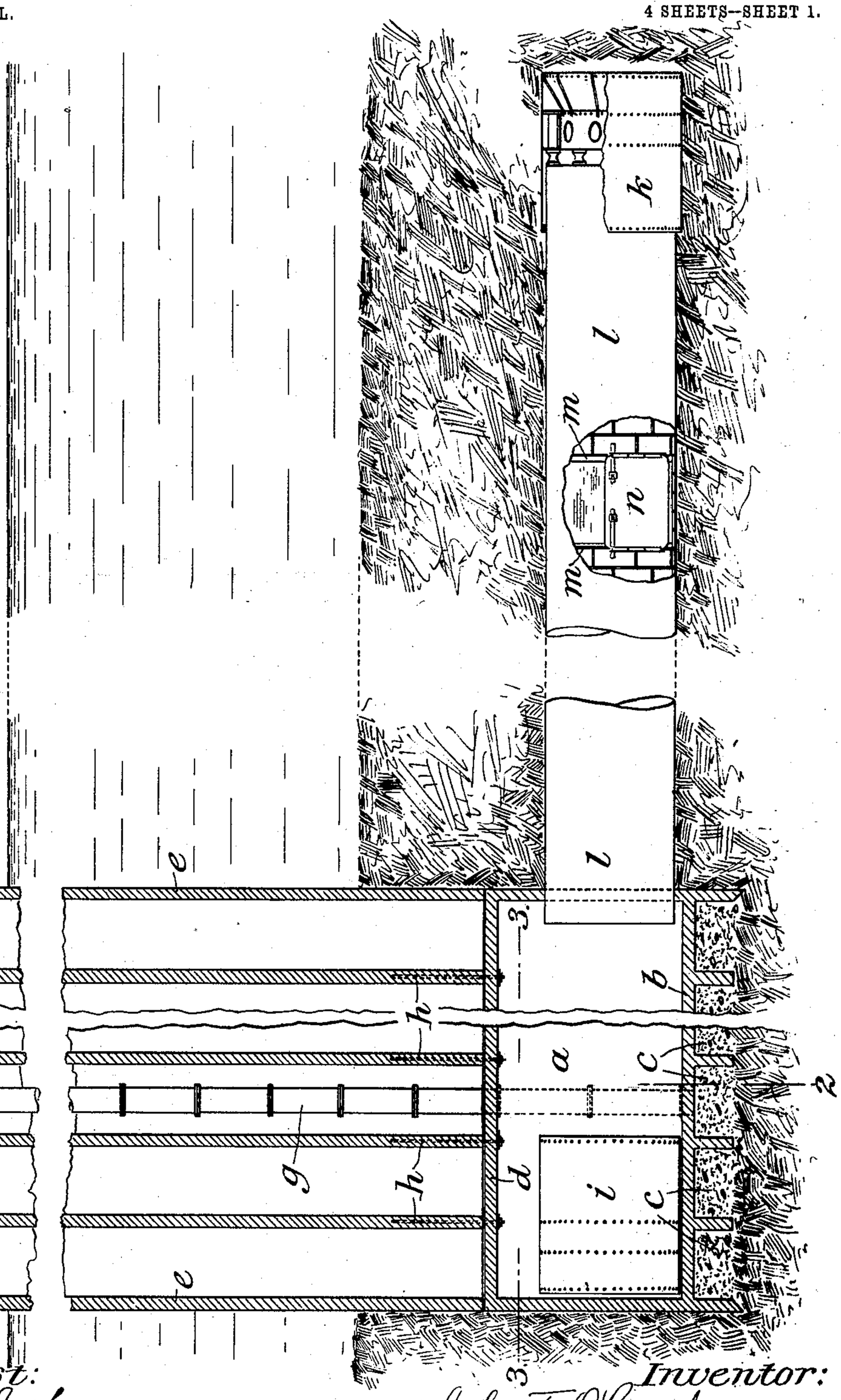
J. F. O'ROURKE.

TUNNEL CONSTRUCTION.

APPLICATION FILED JAN. 20, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.



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NO MODEL. 4 SHEETS—SHEET 2.

Fig. 2.

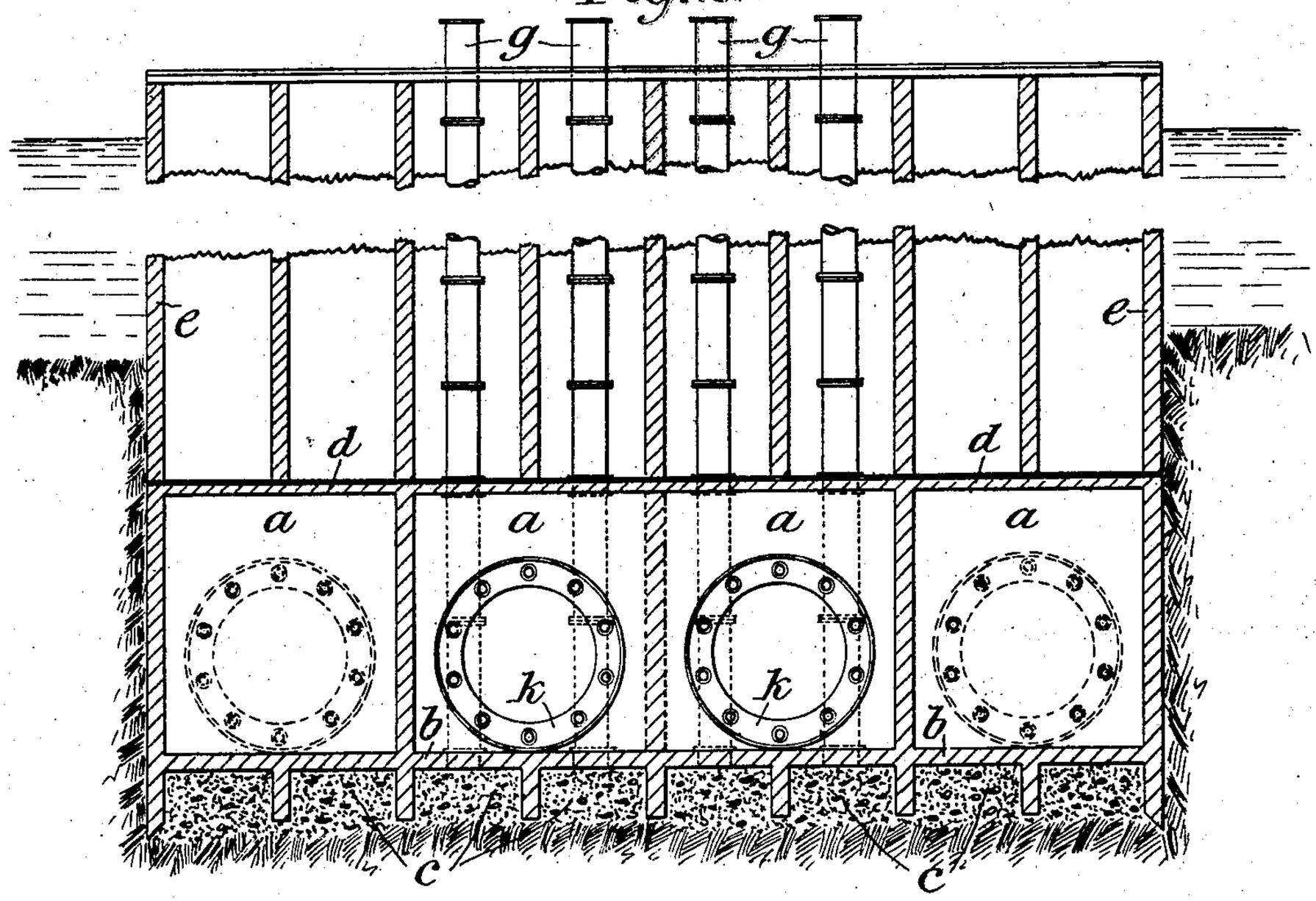
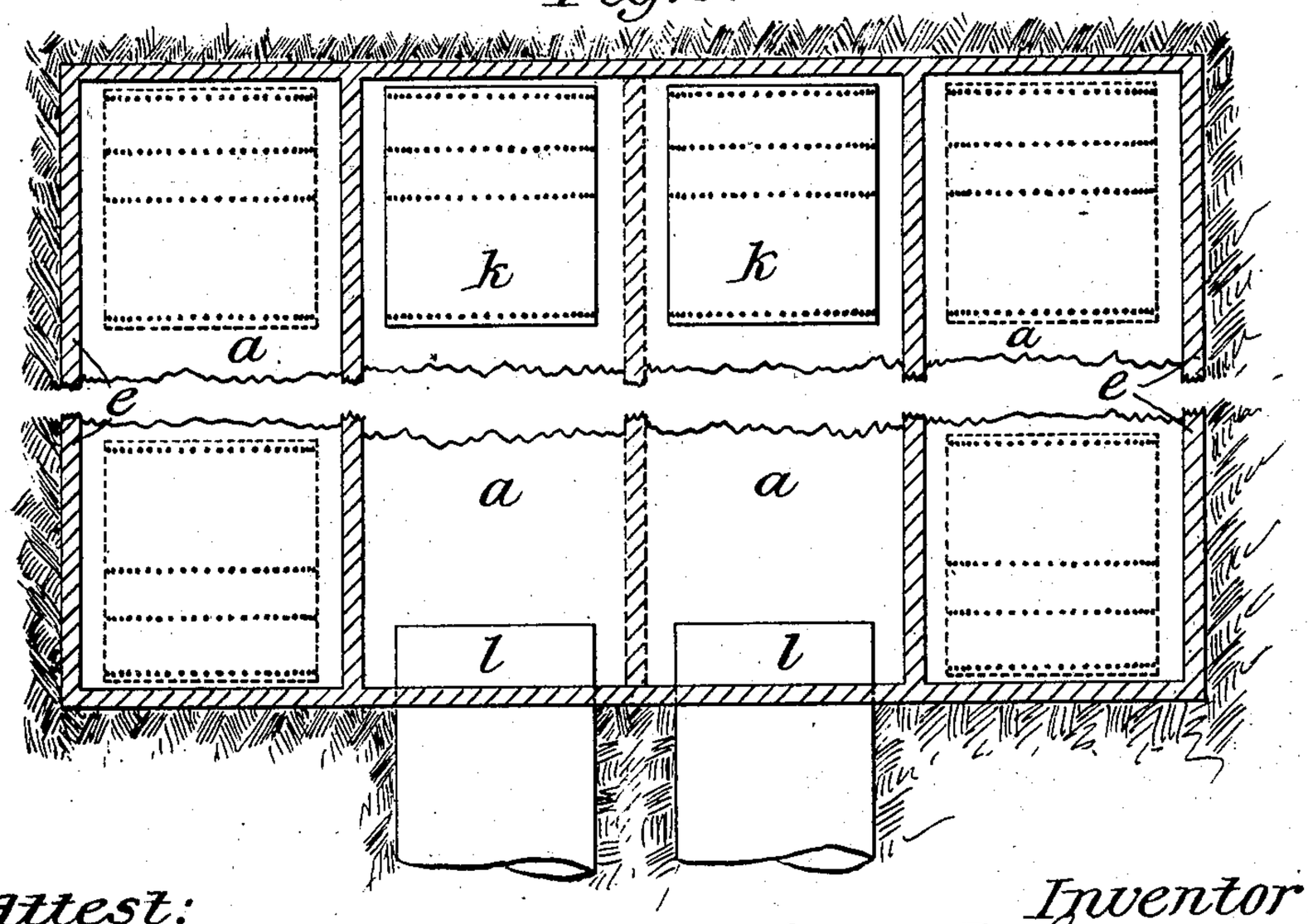


Fig. 3.



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NO MODEL. 4 SHEETS—SHEET 3.

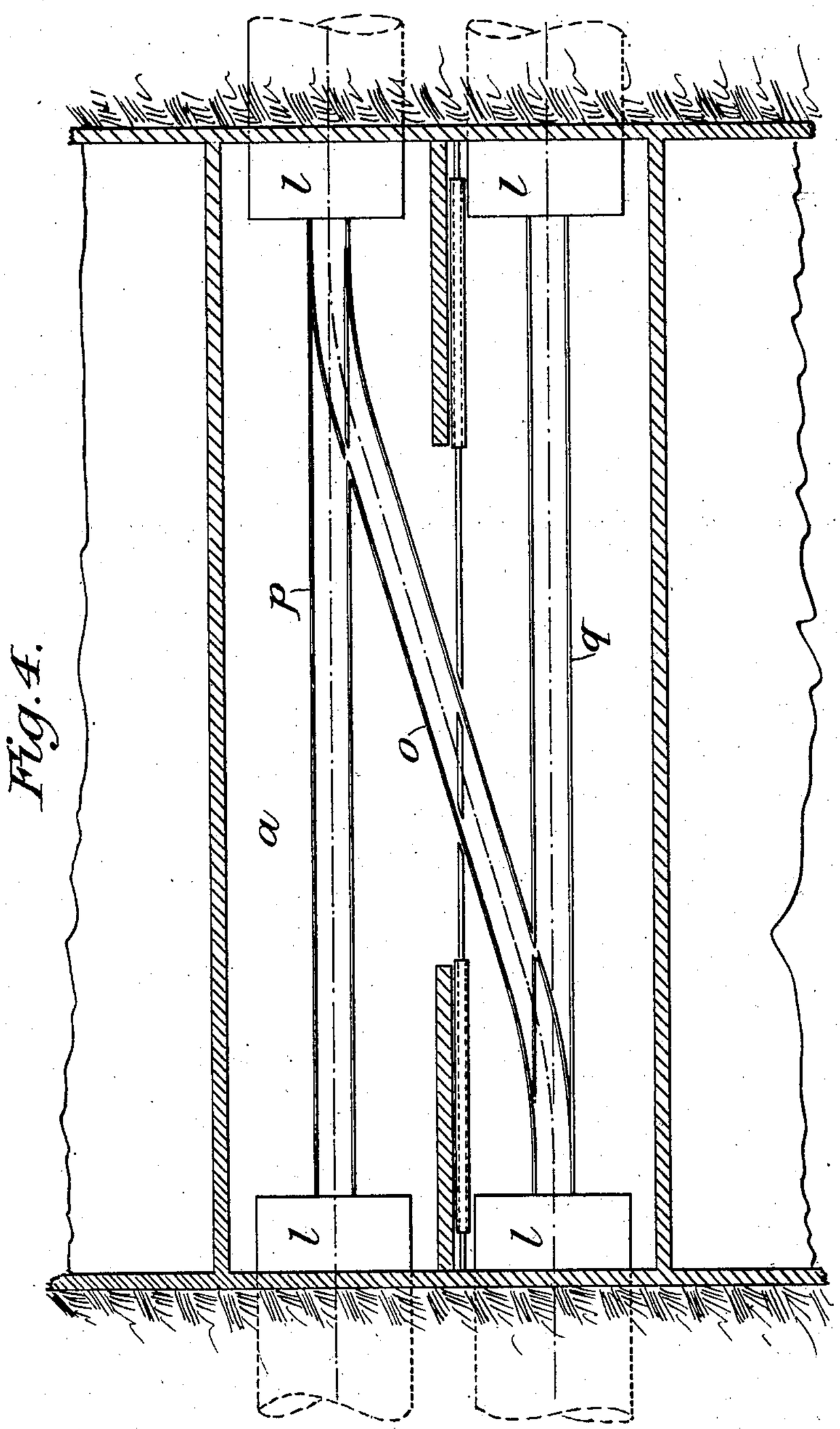

Fig. 4.

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NO MODEL. 4 SHEETS—SHEET 4.

Fig. 6.

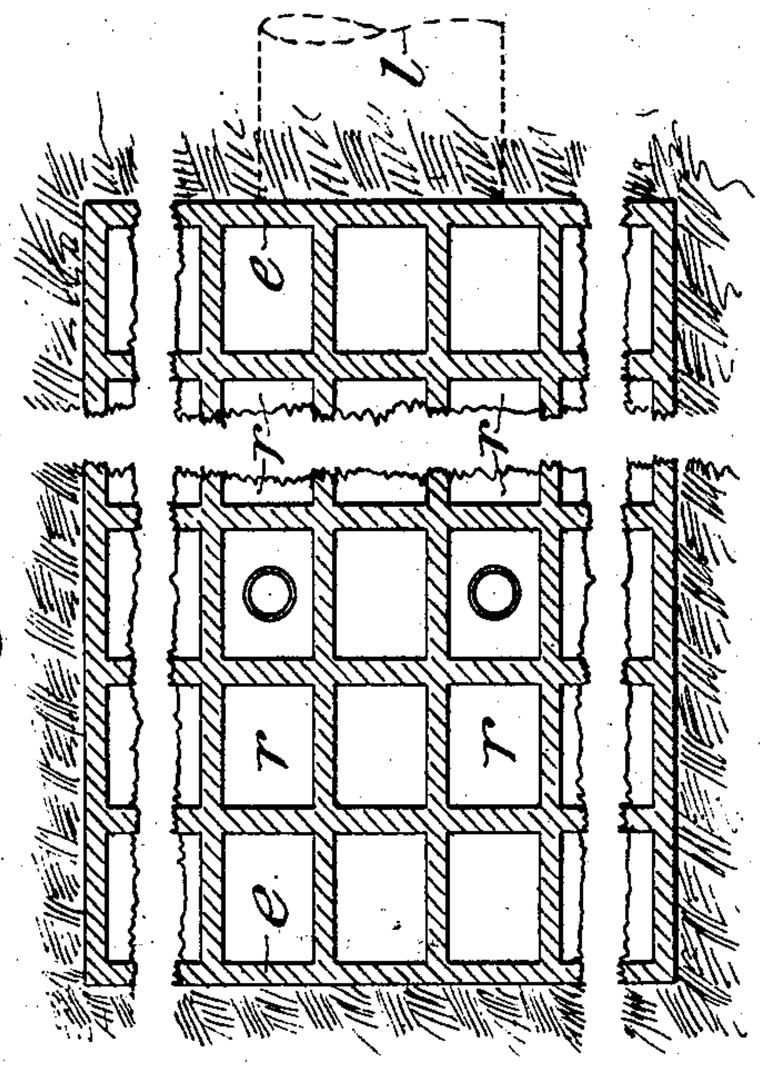
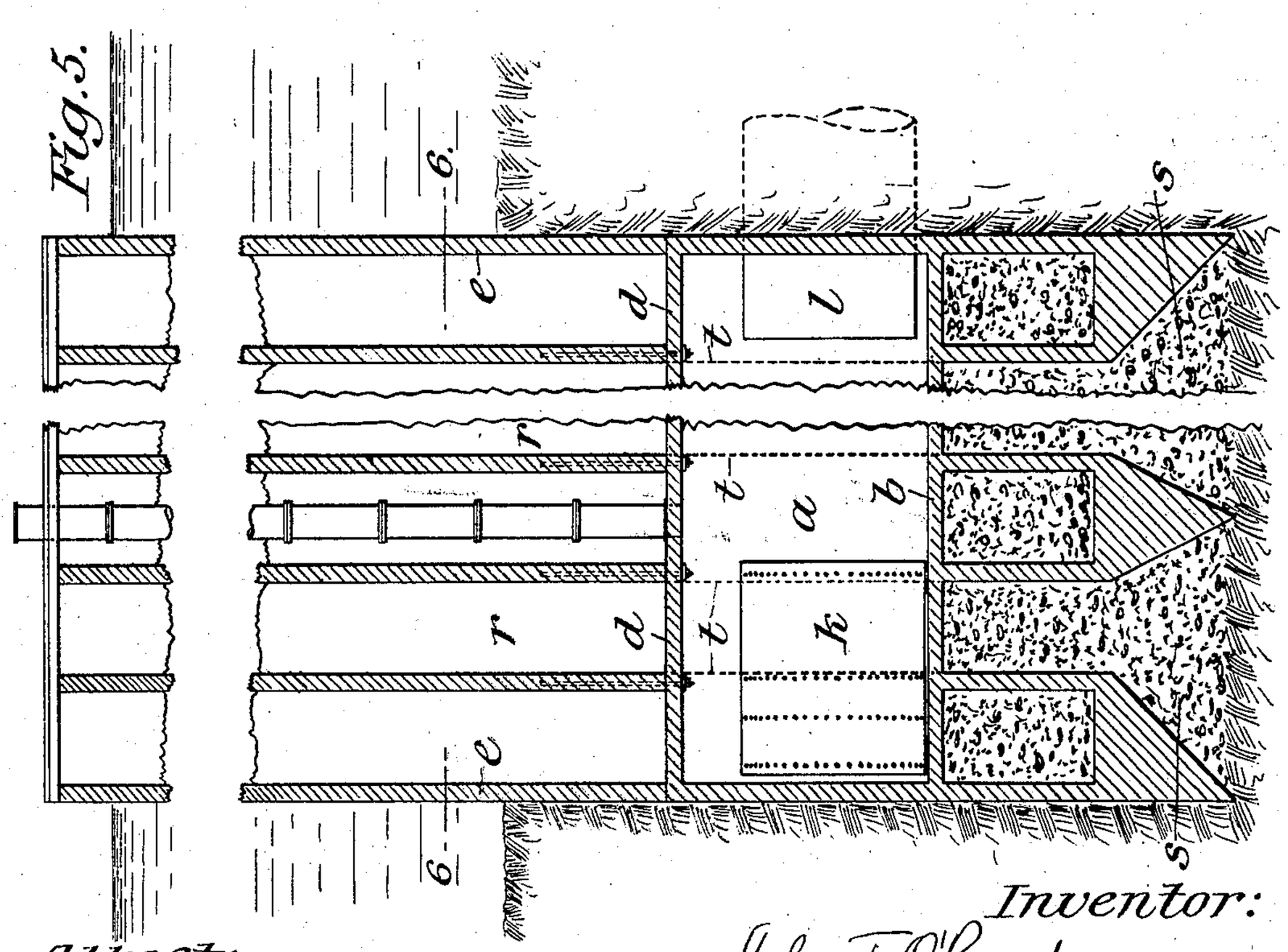


Fig. 5.



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No. 742,222. Patented October 27, 1903.

UNITED STATES PATENT OFFICE.

JOHN F. O'ROURKE, OF NEW YORK, N. Y.

TUNNEL CONSTRUCTION.

SPECIFICATION forming part of Letters Patent No. 742,222, dated October 27, 1903.

Application filed January 20, 1903. Serial No. 139,794. (No model.)

To all whom it may concern:

Be it known that I, JOHN F. O'ROURKE, a citizen of the United States, residing in the borough of Manhattan, in the city of New York, in the State of New York, have invented certain new and useful Improvements in Tunnel Construction, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

Tunnels are usually built beneath bodies of water and under other conditions which require the maintenance of air-pressure at the heading by sinking a shaft where the work can be carried on at atmospheric pressure and excavating the tunnel from the shaft, bulkheads being placed in the tunnel, so that air-pressure can be maintained at the heading when the conditions require. This makes it necessary sometimes to transport the debris through a considerable length of tunnel, besides limiting the work to a single heading and requiring it to be carried on at a great distance from a place of safety in case of accident. Moreover, even when two or more tunnels are to be built side by side and close together each tunnel has to be built independently, multiplying the expense by the number of tunnels, and it is practically impossible to provide for communication between adjacent tunnels either when the work is progressing or, more especially, when the tunnels have been completed. Again, it is impossible to make in advance any provision for the construction at a subsequent time of additional tunnels, which must be built in the same manner as the original tunnel.

It is the object of this invention to provide a structure which will permit the work to be begun at any point where air-pressure above atmospheric is required, as at a point beneath a body of water, thereby making it possible to carry on the work simultaneously at two headings, besides reducing the distance for which it is necessary to transport debris before raising it and providing a place of refuge nearer the headings.

A further object of such structure is to permit the passage of men and materials from one tunnel to another and provide an additional place of refuge in case of accident when two tunnels are being built side by side, to provide a place in which it shall be possible for trains to pass from one tunnel to another, if necessary, after the completion of the tunnels, and to provide for the subsequent building of additional tunnels at any time without incurring the full expense incident to the beginning of entirely independent tunnels.

To accomplish these objects, a structure is provided comprising a temporary crib or casing through which the work is carried on from a point above the surface of the water or water-saturated earth and which is subsequently removed if in navigable water, a working chamber in which is carried on the work of excavating for the placing of the crib or caisson, and an intermediate chamber from which the excavation of the tunnel can be commenced and carried on as far as need be under air-pressure and which forms a permanent part of the tunnel, constituting, if need be, a chamber in which the passage of trains from one tunnel to another is possible.

The structure will be more fully described hereinafter with reference to the accompanying drawings, in which it is illustrated, and in which—

Figure 1 is a view in longitudinal vertical section showing the structure in place and a portion of the tunnel excavated from the intermediate or supplemental chamber. Fig. 2 is a transverse section on the plane indicated by the line 2 2 of Fig. 1. Fig. 3 is a horizontal section on the plane indicated by the line 3 3 of Fig. 2, partly broken out to save space. Fig. 4 is a view similar to Fig. 3, but showing the structure with tracks to carry trains from one tunnel to another. Fig. 5 is a view in longitudinal vertical section, partly broken out, generally similar to the left-hand portion of Fig. 1, showing the embodiment of the improvement in a structure placed by the dredging method. Fig. 6 is a horizontal section on the plane indicated by the line 6 6 of Fig. 5, also partly broken out.

The structure, which is placed at the point where the excavation of the tunnel is to be begun and from which the work is to be carried forward, comprises a pneumatic caisson having auxiliary chamber *a*, working chambers *c* beneath the floor *b* of the chamber *a*, and a crib or upper portion *e* above the roof *d* of the chamber *a*. This structure may be

built in any convenient manner and of any suitable materials, the chamber *a* being so constructed as to permit the necessary air-pressure to be maintained therein and to resist external pressure, being adapted to remain as a permanent structure, forming eventually a portion of the tunnel. The width of this chamber *a* may be such as to accommodate a single tunnel only, having a diameter sufficiently great to permit the exact placing of the tunnel with reference to its end walls without requiring the structure itself to be exactly placed, or it may be sufficient to accommodate two or more tunnels side by side, the longitudinal walls between adjacent sections being permitted to remain in place to permanently separate the adjacent tunnels or being removed in whole or in part either for convenience in beginning the excavation of adjacent tunnels or for the purpose of allowing communication for men, materials, or trains between adjacent tunnels. The length of the chamber will also be suited to the requirements of the case, being sufficient, if necessary, to permit the placing of a crossover *o* for trains from the tracks *p* of one tunnel to the tracks *q* of another, as indicated in Fig. 4.

Beneath the floor *b* of the chamber *a* are the working chambers *c*, in which may be carried on the work of excavation for the proper placing of the complete structure, the air-shaft *g* being carried through the chamber *a* into the working chambers beneath if it is necessary to carry on the work of excavation under air-pressure. These working chambers may eventually be filled with concrete or other material to form a suitable foundation for the chamber *a* when it becomes a permanent part of the tunnel structure.

The crib or upper portion *e* of the caisson above the roof of the chamber *a* is adapted for the proper placing of the chamber *a* and for the carrying on of the work therein. Where its presence is unobjectionable, it may be allowed to remain to provide shafts for the proper ventilation of the tunnel when completed. Otherwise, as when placed in navigable waters, it may be removed above the roof of the chamber *a* when the work of excavating the tunnel has been completed.

When the chamber *a* has been placed, the necessary air-pressure is established therein and the end walls, either one or both, are broken through and the excavation of the tunnel is commenced. Shields *i*, formed within the chamber *a*, may be projected through the end walls of the chamber and be carried forward as the excavation of the tunnel progresses if the character of the material through which the tunnel is to be built is such as to require it. The lining *l*, which follows the shield, is also carried through the end wall of the chamber *a*, the joint between the lining and the end wall being made tight in any suitable manner.

The provision of a chamber *a* of such dimensions as are possible in a structure of the character referred to in which air-pressure can be maintained affords a convenient and commodious place from which the work of excavating the tunnel can be carried on and is therefore advantageous even when a single tunnel is to be built. If a second tunnel is to be built simultaneously, each chamber-section becomes for the other a convenient refuge in case of accident, suitable doors being provided in the dividing-wall, or if the dividing-wall is removed the chamber becomes still more commodious for the carrying on of the work of excavation. If the later addition of other tunnels is contemplated, additional chamber-sections may be provided in the structure at the outset with comparatively slight extra expense, and when the additional tunnel is to be built it is easy to break through laterally from one chamber-section into the next for the purpose of beginning the tunnel-excavation. Moreover, the provision of a chamber common to two or more tunnels makes possible that which is not feasible in ordinary tunnel construction—namely, the passage of tram-cars from one tunnel to another, as indicated by the crossover *o*. (Shown in Fig. 4.) Various other advantages inhere in the provision of an auxiliary chamber, as herein described, but they need not be enumerated herein.

It is obviously immaterial how the structure which comprises the air-pressure chamber is placed. Thus it may be placed by the pneumatic method, for which the structure shown in Fig. 1 is adapted, or by the dredging method, for which the structure shown in Figs. 5 and 6 is adapted, being provided with dredging-pockets and which in the outset are carried through to the dredging or working chambers *s* in the bottom, the walls of the pockets being carried through the air-pressure chamber *a*, as indicated by dotted lines in Fig. 5. Subsequently the floor *b* and roof *d* of the air-pressure chamber are completed across the pockets, as shown in Fig. 5, and the walls thereof within the chamber are removed.

It will be understood that various other changes in the details of construction may be made to meet the requirements of each case without departing from the spirit of the invention.

I claim as my invention—

1. A structure for tunnel-building comprising a crib or upper portion, a working chamber, and an intermediate air-pressure chamber forming a permanent structure and from which the work of excavation can be carried on.

2. A structure for tunnel-building comprising a crib or upper portion, a working chamber, and an intermediate air-pressure chamber from which the work of excavation can be carried on, said air-pressure chamber and said working chamber forming a permanent

structure and said crib or upper portion being removable from said permanent structure.

3. A structure for tunnel-building comprising a crib or upper portion, a working chamber, and a plurality of adjacent, intermediate air-chambers forming a permanent structure, between which air-chambers communication may be had and from each of which the work of excavation can be carried on.

4. A structure for tunnel-building comprising a crib or upper portion, a working chamber, an intermediate air-pressure chamber forming a permanent structure and from which the work of excavation can be carried on, and an air-shaft extended through the crib or upper portion and adapted to be extended downward through the intermediate air-chamber to the working chamber.

5. The combination with a plurality of tubular tunnels of a chamber located at an intermediate point and comprising a plurality of sections corresponding respectively with the several tunnels.

6. The combination with a plurality of tubular tunnels of a caisson-like permanent structure, comprising a chamber, placed at an intermediate point and as wide as the several tunnels in the aggregate and providing for intercommunication between the several tunnels.

7. The combination with a plurality of tubular tunnels of a caisson-like permanent structure, comprising a chamber, placed at an intermediate point and as wide as the several tunnels in the aggregate, railway-tracks in the several tunnels and a railway-cross-over in the caisson-like structure from one tunnel-track to another.

This specification signed and witnessed this 17th day of January, A. D. 1903.

JOHN F. O'ROURKE.

In presence of—
ANTHONY N. JESBERA,
W. B. GREELEY.