

No. 724,666.

PATENTED APR. 7, 1903.

T. COOPER.

TUNNELING SHIELD.

APPLICATION FILED JAN. 26, 1903.

NO MODEL.

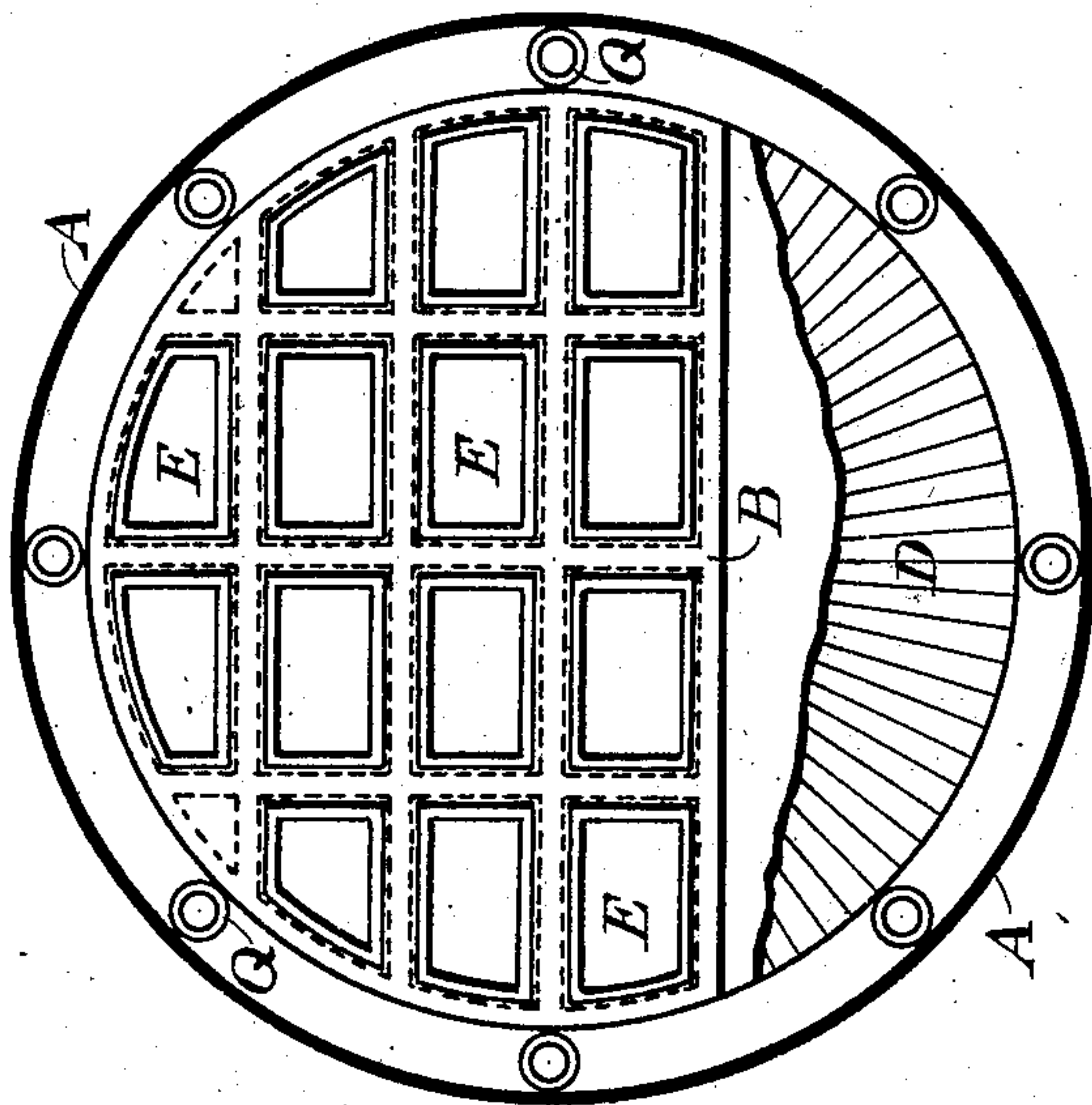
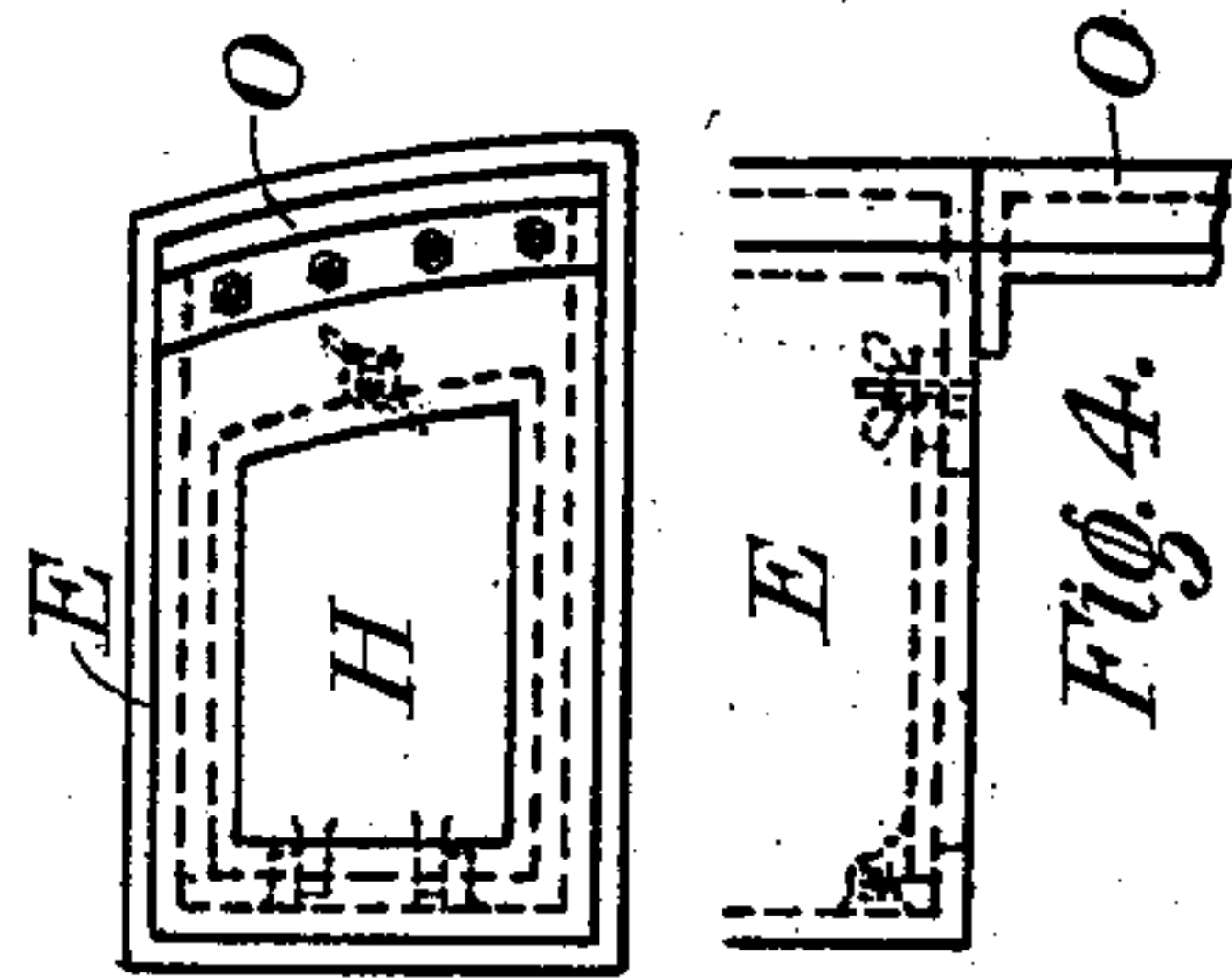
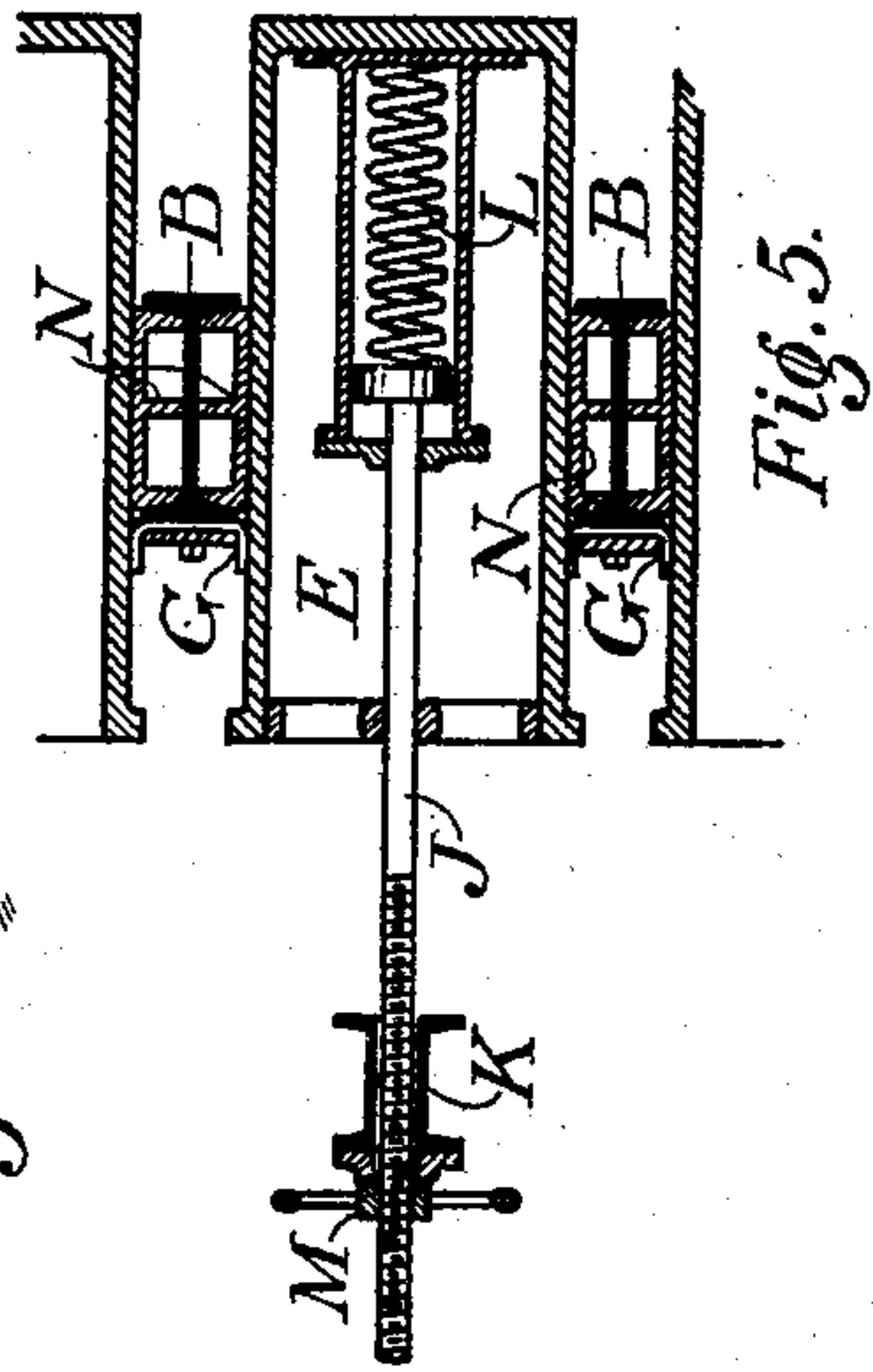
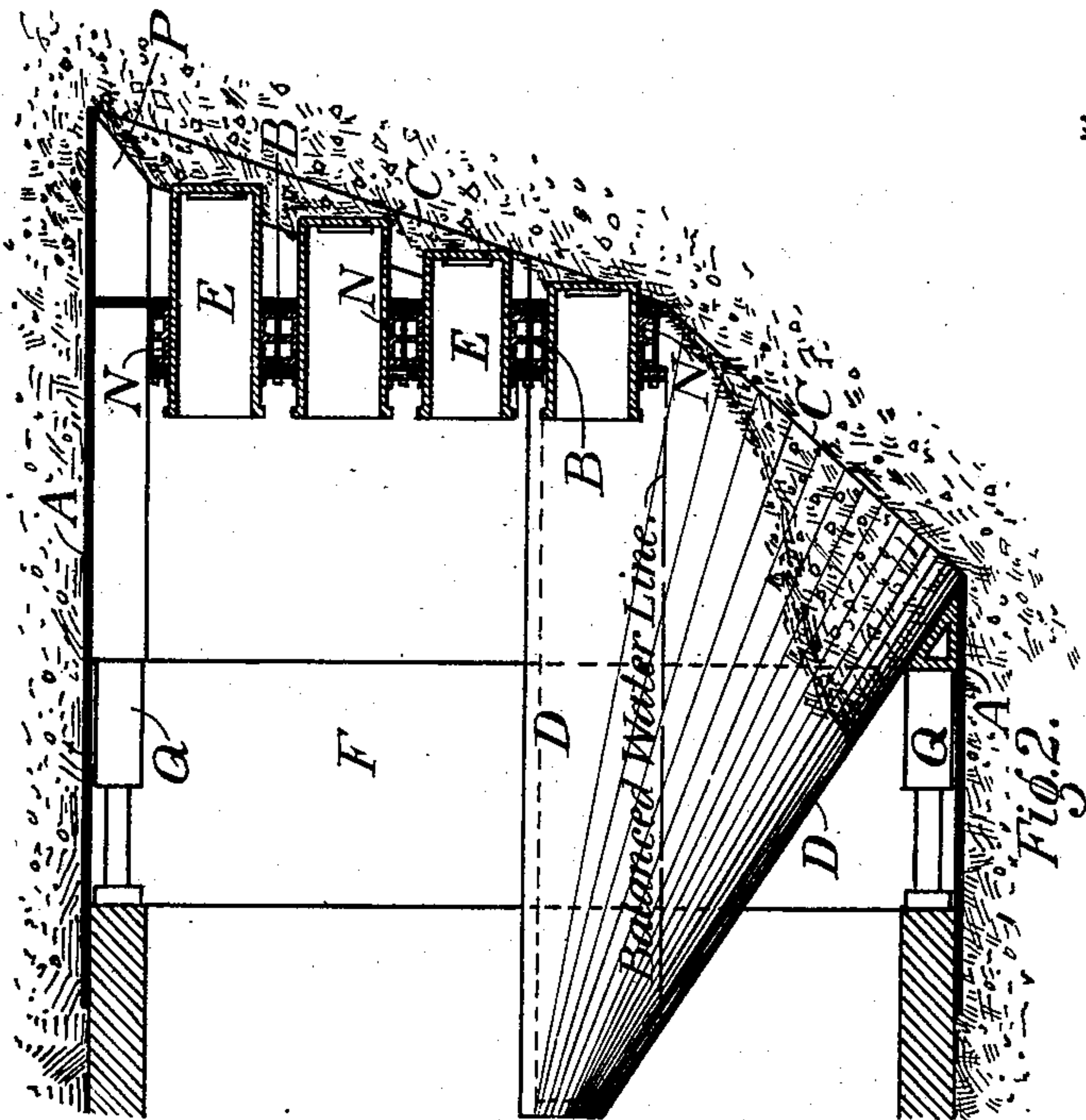


Fig. 1.

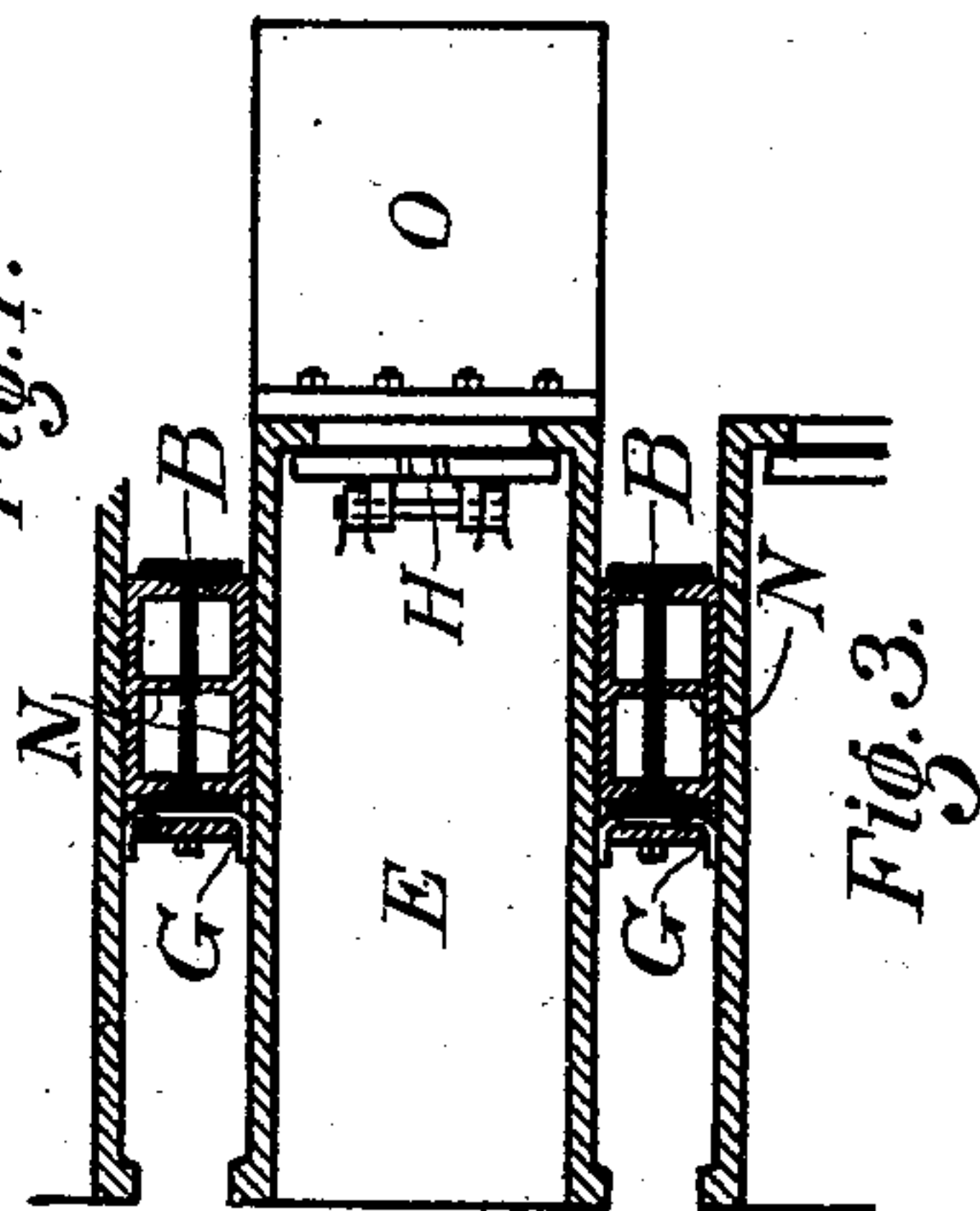


Fig. 3.

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TUNNELING-SHIELD.

SPECIFICATION forming part of Letters Patent No. 724,666, dated April 7, 1903.

Application filed January 26, 1903. Serial No. 140,670. (No model.)

To all whom it may concern:

Be it known that I, THEODORE COOPER, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Tunneling-Shields, which are particularly designed for tunneling through loose or granulated material, such as earth, sand, or gravel, of which the following is a specification.

15 The object of my invention is to reduce the amount of material to be removed in advance of the shield to a minimum, and thereby to increase the efficiency of the old method of tunneling, and also to avoid the risks of subsidence of the superimposed ground, and consequent injury of structures resting thereon. The means heretofore employed in this tunneling method for advance working have been poling-boards, bulkheads, or movable shutters to restrain the flow of material or, on the other hand, a long projecting hood in front of the shield extending beyond the natural slope of the material to be excavated. The first of these means has necessitated working by men stationed in advance of the forward bulkhead of the shield, which involves risk and expense in the case of water-bearing materials and is impracticable where the water-balance is to be maintained. In the second method the long hood increases to an inconvenient extent the length and weight of the shield, and because of the heavy eccentric load sustained by the hood there is difficulty in keeping the shield in true alinement.

35 My invention resides in the combination, with a shield, of devices projecting forward of the front bulkhead for adjusting and maintaining the angle of slope of the external material facing the forward end of the shield and consisting of revetment-shutters of a new and peculiar form, which are operated from within the air-chamber of the shield, preferably automatically. The shutters just mentioned consist, in substance, of movable plungers of any desired cross-sectional form mounted in openings extending through the forward bulkhead or stiffening-frame of the shield and fitted with suitable guides. These plungers are preferably hollow and open toward the rear, so as to be subjected to the internal air-pressure in a pneumatic shield or to the action of screw-jacks, springs, hydraulic

pressure, or other mechanical appliance that may be used in their operation. By such means the shutters are automatically forced forward through the bulkhead and maintained under pressure against the receding face of the material in front of the shield as such material is excavated from below. By thus maintaining a constant retaining pressure on the material in front of the shield while the excavation is carried on from below the face of the material can be held at a steep angle well within the limits of a moderate-sized hood. By this means the amount of material to be removed as the shield advances will be reduced to a minimum.

In a pneumatic shield where a water-balance is maintained behind the forward bulkhead the pressure needed to retain the material at a steep angle, as aforesaid, will be far less than in the methods heretofore used, since the water-head and such portion of the weight of the material as is represented by its buoyancy will be balanced by the internal air-pressure, leaving only the weight of the material less its buoyancy to be counterbalanced by the pressure which restrains the flow of such material. In this shield the internal air-pressure for all points above the balanced water-line will be in excess of the external hydrostatic pressure, being approximately sixty pounds per square foot of vertical surface for each foot of height above the water-level. Hence the shutters sliding through the openings in the forward bulkhead will be pressed and held by the air against the face of the external material. For the lower tier of shutters, where the pressure is lowest, it may be found desirable to supplement the air-pressure by screw-jacks, springs, or other mechanical devices. The position of the shutters will also indicate within the air-chamber the progress of the external excavation and the slope of the external material, which can be modified and controlled by changing the point of excavation or by relaxing the pressure on certain shutters. The shield itself may be pushed forward steadily or at intervals, the shutters being free to move backward through the forward bulkhead as the shield advances without relaxing their pressure on the face of the material in front. The pressure applied to the shutters

will be less than and independent of that required for moving the shield. It is also applied to the shutters individually. The front ends of the shutters should be fitted with traps, which can be opened for exploration or for loosening the material or for other purposes. Their front faces may be either square or inclined to the axis of the shutters. Preferably the shutters should be so arranged that any one or all of them can be entirely withdrawn from the bulkhead or frame and the openings then closed with a plate or trap, if desired. Moreover, the shutters near the periphery of the shield can, if desired, be fitted with projecting or poling plates to act as a supplementary hood, which may be forced beyond the permanent hood and act as an extension thereof.

The accompanying drawings represent that form of my invention which I now regard as the best one out of the various forms in which the principle of the invention may be applied.

In the drawings, Figure 1 is an end elevation of the shield viewed from the inside with my invention applied thereto. Fig. 2 is a vertical longitudinal section of the shield shown in Fig. 1. Figs. 3, 4, and 5 show details of the construction.

In the drawings, A is a hollow cylindrical casing forming the shell of the shield and suitably braced.

B is the forward vertical bulkhead, closing the front end of the shield, with the exception of the lower third thereof, which is left open to communicate with the external material.

D is a conical rear bulkhead constructed in accordance with the principles of the invention shown in my Patent No. 715,244, dated December 9, 1902.

P is a short projecting hood extending in front of the bulkhead B.

Q Q are the hydraulic jacks for advancing the shield.

The forward bulkhead B is perforated by a series of openings, which in the present illustration are of substantially rectangular shape and provided with bearings in which may slide the shutters E, which are hollow, but closed at the front and open at the rear, and fit snugly within the perforations. Stuffing-boxes G serve to pack the shutters within the perforations when the shutters are operated by the internal air-pressure and make a tight joint, while still allowing the shutters to move in and out. The shutters E are shown as decreasing in length from the top to the bottom tiers, corresponding in general to the limiting-slope within which it is desired to maintain the face of the external material.

As shown in Figs. 3 and 4, the front ends of the shutters are provided with traps H, hinged on the inside, so as to open inward, and fastened by a latch, as particularly shown in Fig. 4. There is also shown in Figs. 3 and 4

a poling-plate O, attached to the edge of one of the shutters on the side of the shield. This plate projects forward from the shutter into the material in front and serves to restrain the flow of the material.

In Fig. 5 the shutter E is shown as operated by a screw and spring, which may be supplementary to the air-pressure or, if desired, used alone. In this figure, L is a spring seated against the inner face of the shutter in a cylinder wherein moves a piston on the end of rod J, so that the spring may be compressed by pressure applied to the rod. The opposite end of the rod is screw-threaded and passes through a corresponding threaded sleeve set into the stanchion K and provided with a hand-wheel M. In all of these arrangements the pressure is elastic, allowing the shutters to automatically adjust themselves to the face of the receding material.

In dry ground with or without internal air-pressure the after bulkhead D may be omitted.

In operation the material in front of the shield will be excavated through the opening in the lower part of the forward bulkhead, and as the work proceeds the slope of the material facing the end of the shield will be controlled by the shutters, that are pressed out against it, as already described. The slope and shape of the face of the material may also, as above mentioned, be adjusted as desired by regulating the pressure on the several shutters. By this means I avoid, as aforesaid, the need for a long overhanging hood and also limit the excavation to the amount required for the passage of the shield.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a tunneling-shield of a forward bulkhead therefor having an opening in its lower part through which the excavation is carried on and means for adjusting and maintaining the angle of slope of the external material facing the end of the shield.

2. The combination with a tunneling-shield of a forward bulkhead having an opening in its lower part through which the excavation is carried on, and a series of devices projecting forward of the bulkhead for adjusting and maintaining the angle of the slope of the external material facing the shield as such material is excavated from beneath.

3. The combination with a tunneling-shield of a forward bulkhead or frame pierced with a series of openings and revetment-shutters in the form of plungers contained in said openings and movable longitudinally therein.

4. The combination with a tunneling-shield of a forward bulkhead or frame pierced by openings, shutters mounted in said openings and movable therein and means for applying and maintaining pressure upon the shutters.

5. The combination with a tunneling-shield of means for advancing it ahead of the completed tunnel, a bulkhead or frame at the for-

ward end of the shield, slope-retaining devices projecting in front of the bulkhead but movable with respect thereto and means for applying pressure to the said devices less than the pressure required to force the shield forward.

6. The combination with a tunneling-shield of a forward bulkhead or frame, slope-retaining devices projecting through said bulkhead and movable with respect thereto, and means for maintaining a constant pressure of said devices against the external material facing the end of the bulkhead independent of the pressure required to force the shield forward.

7. The combination with a tunneling-shield of a forward bulkhead or frame and movable revetment-shutters projecting through said bulkhead and exposed to the internal air-pressure back of the bulkhead.

8. The combination with a tunneling-shield of a forward bulkhead or frame, a series of revetment-shutters movably mounted in perforations through the said frame or bulkhead and means for applying pressure to said shutters within the shield for holding them against the face of the external material.

9. The combination with a tunneling-shield of a forward bulkhead or frame, revetment-shutters movably mounted in perforations in said bulkhead or frame and means for maintaining internal air-pressure against said

shutters to force and hold them against the face of the external material.

10. The combination with a tunneling-shield of a forward bulkhead or frame, revetment-shutters mounted movably in perforations through said bulkhead or frame, means for applying and maintaining air-pressure against said shutters and mechanical pressure devices supplementing said air-pressure.

11. The combination with a tunneling-shield of a forward bulkhead or frame, revetment-shutters movably mounted in perforations through said bulkhead or frame and elastic pressure devices for forcing the said shutters against the force of the external material.

12. The combination with a tunneling-shield of a forward bulkhead or frame, a series of revetment-shutters movably mounted on said bulkhead or frame and elastic pressure devices acting individually on said shutters to hold them respectively against the face of the external material.

In witness whereof I have hereunto set my hand, before two subscribing witnesses, this 23d day of January, 1903.

THEODORE COOPER.

Witnesses:

BERNT BERGER,
GUS P. MACIAS.