

No. 868,259.

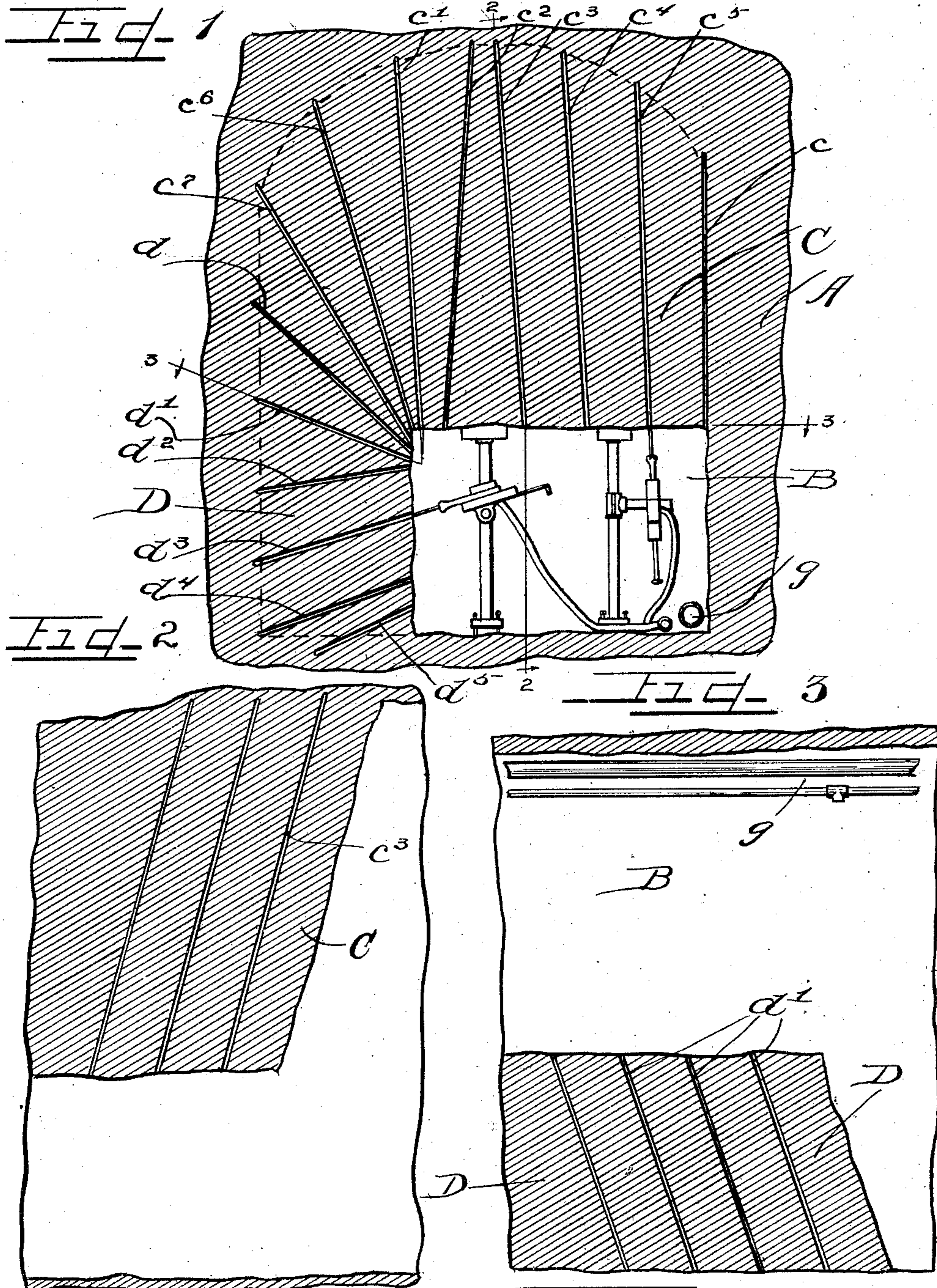
PATENTED OCT. 15, 1907.

P. FORD.

METHOD OF EXCAVATING ROCK TUNNELS.

APPLICATION FILED NOV. 12, 1906.

3 SHEETS—SHEET 1.



WITNESSES

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Fig. 4

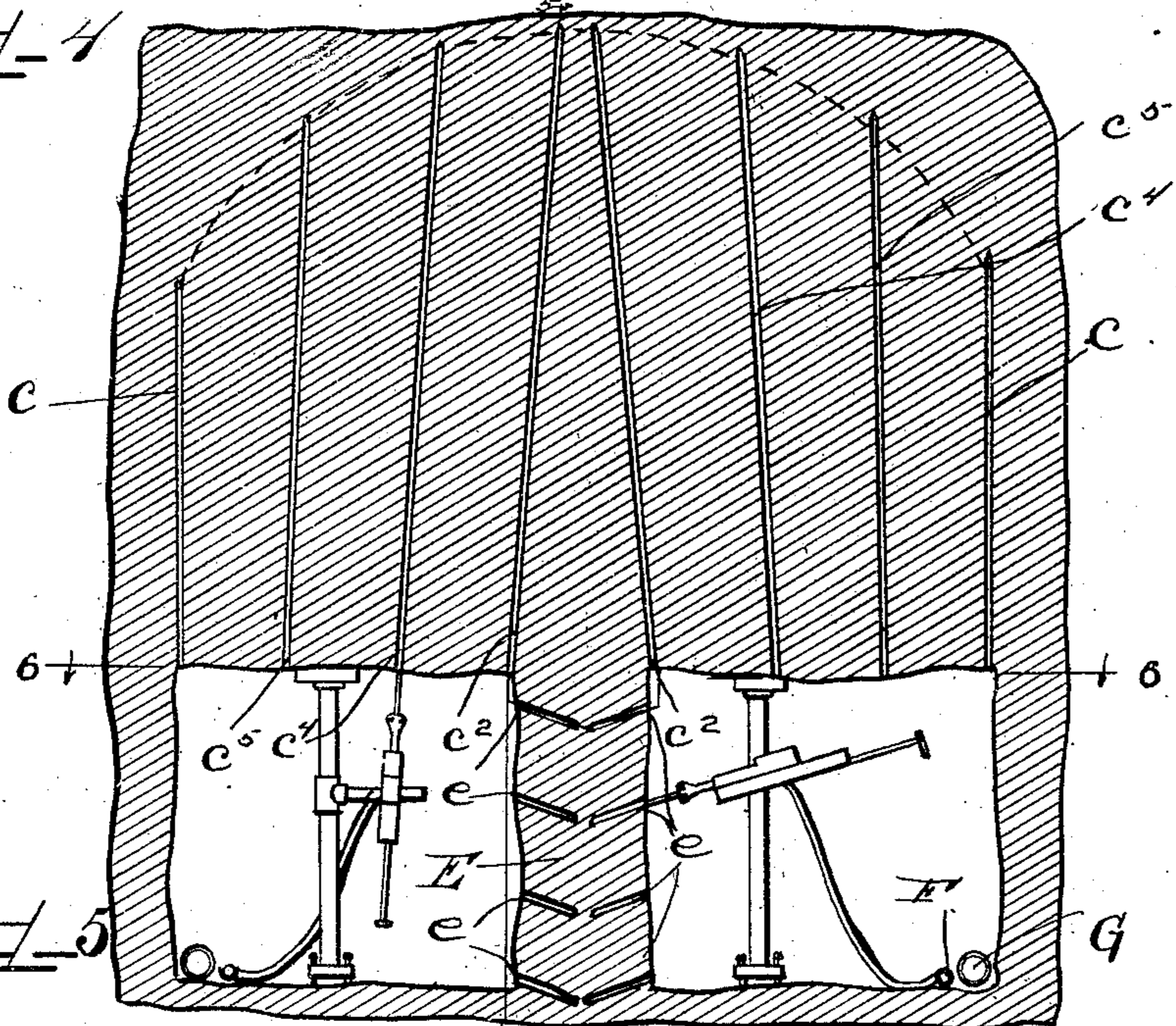


Fig. 5

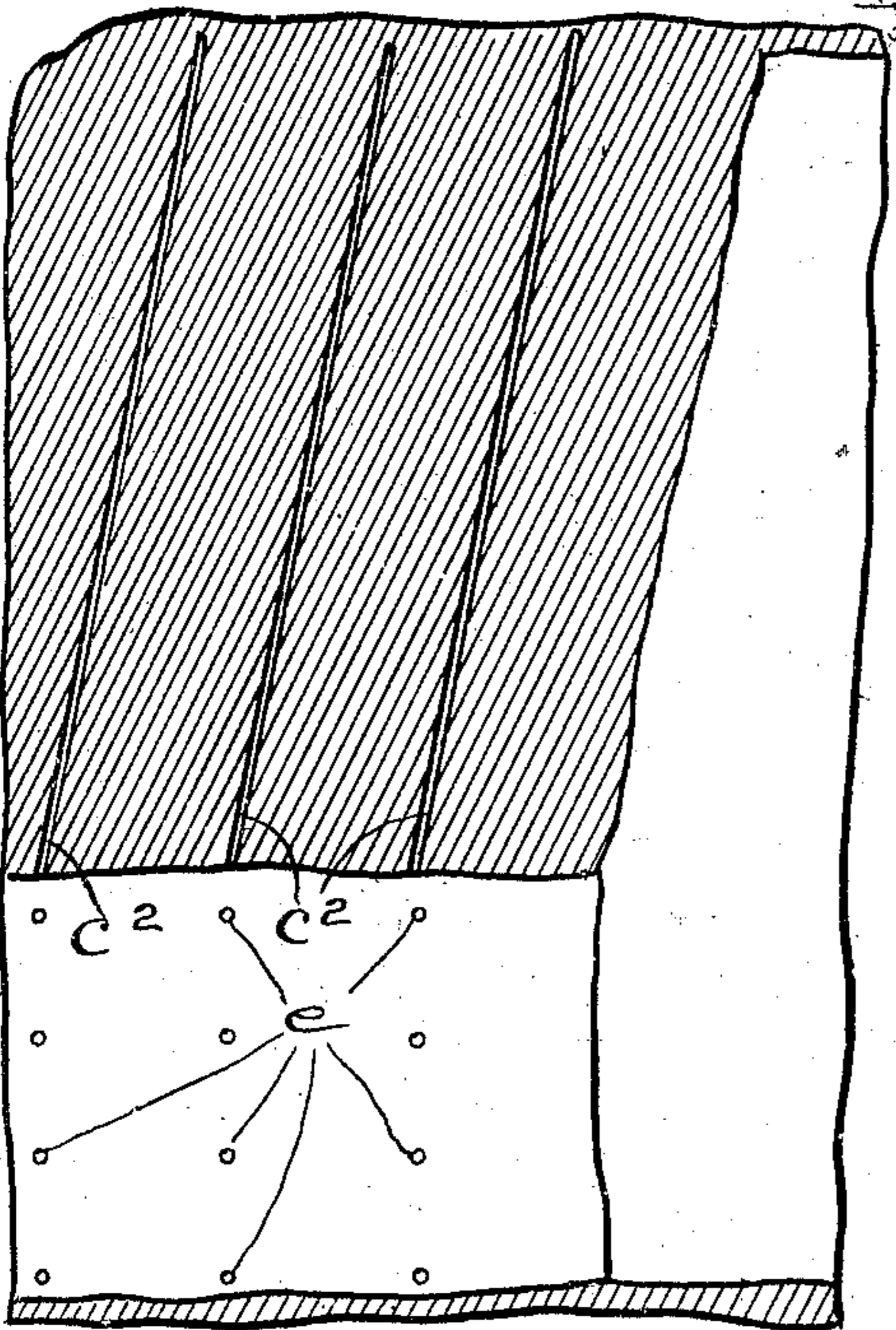
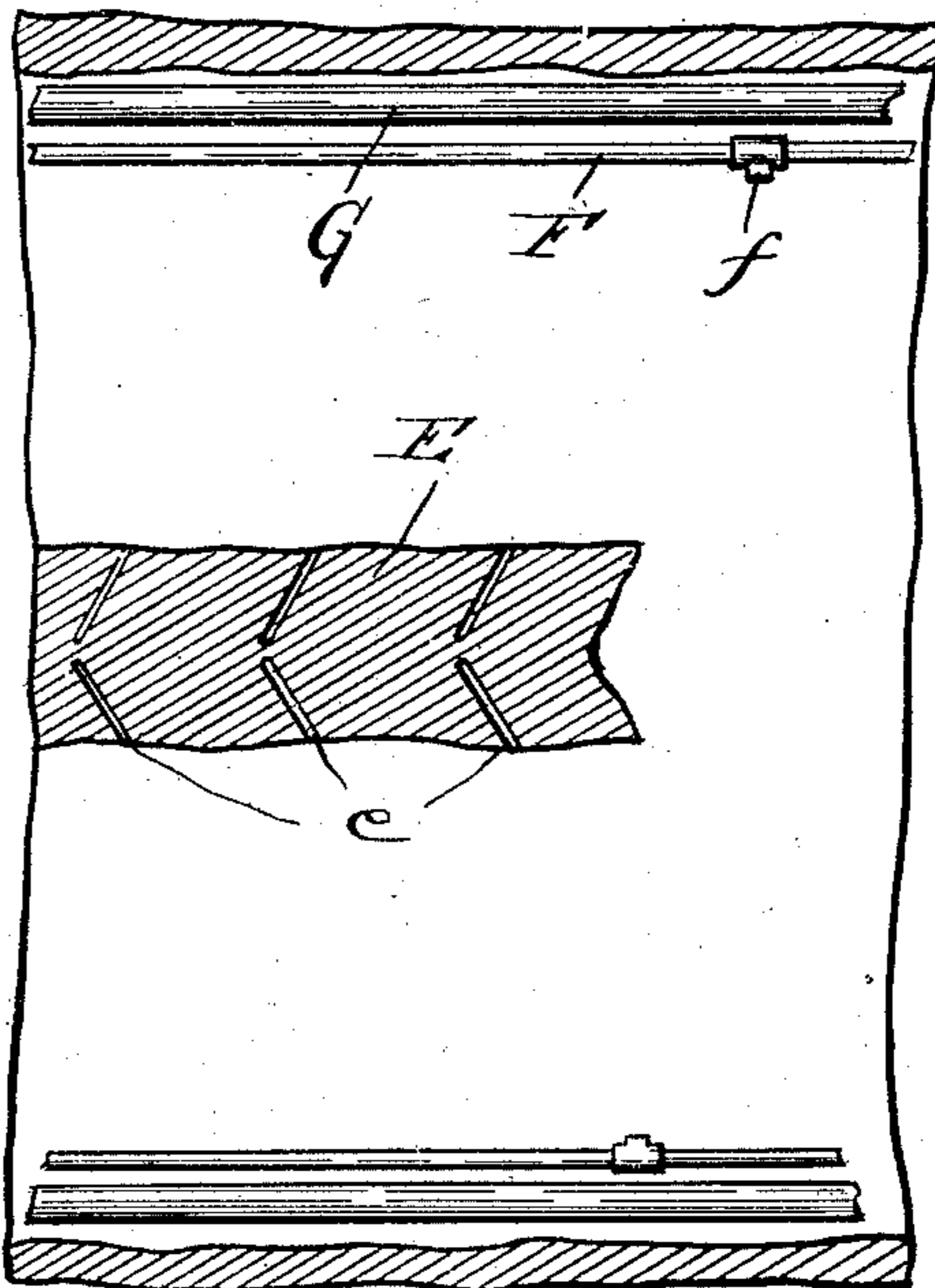


Fig. 6



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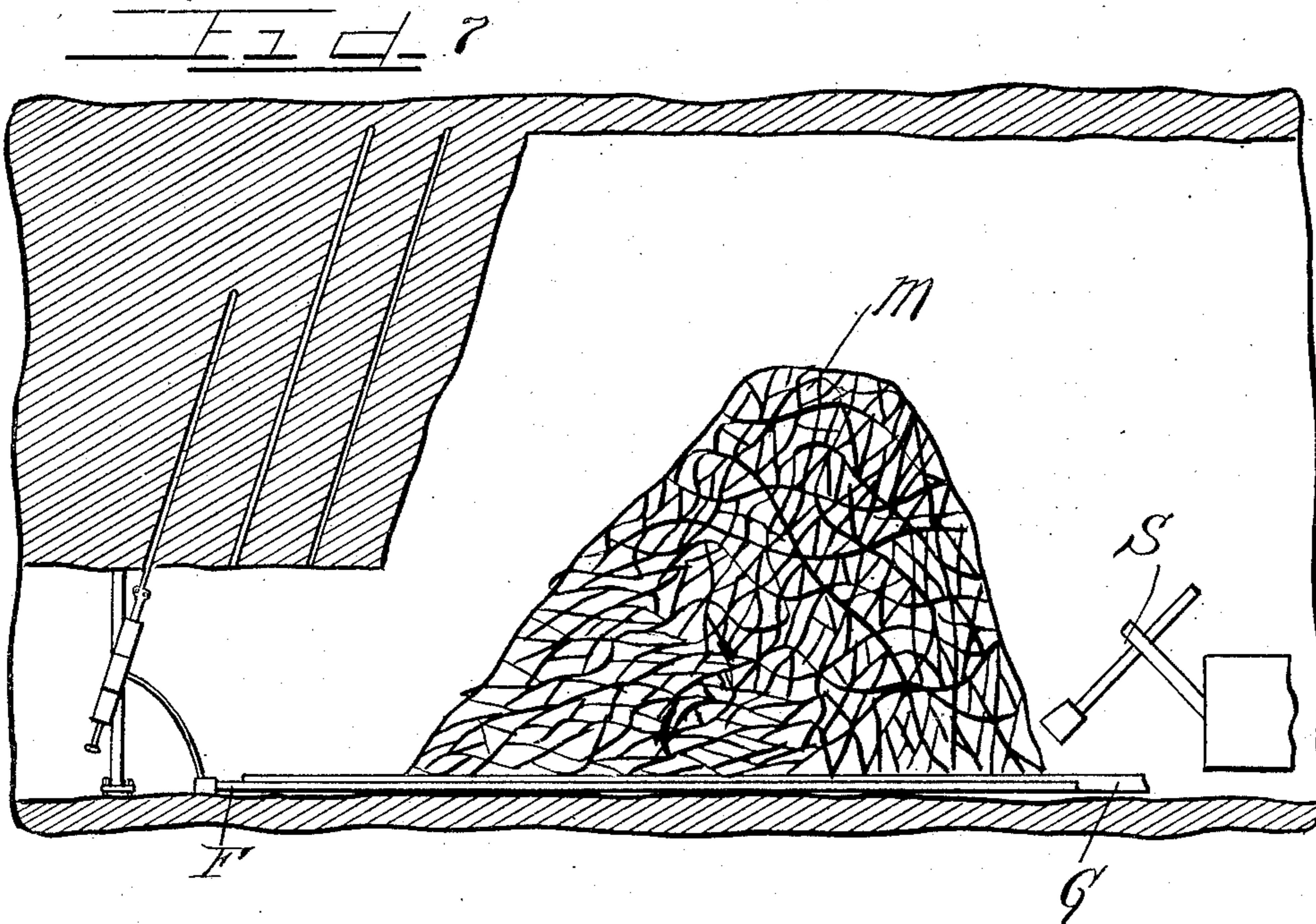
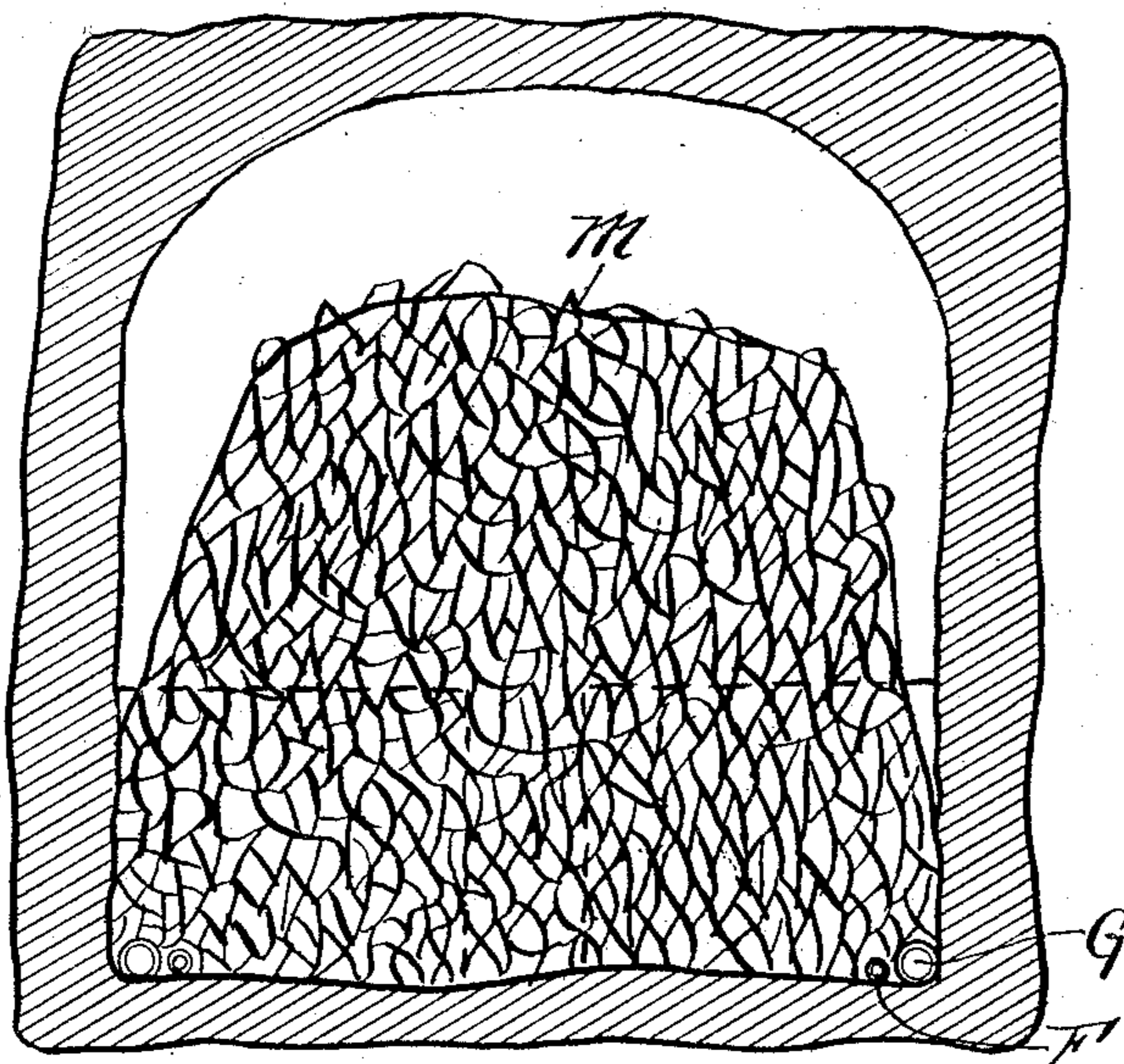


Fig. 8



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UNITED STATES PATENT OFFICE.

PATRICK FORD, OF CHICAGO, ILLINOIS.

METHOD OF EXCAVATING ROCK TUNNELS.

No. 868,259.

Specification of Letters Patent.

Patented Oct. 15, 1907.

Application filed November 12, 1906. Serial No. 343,140.

To all whom it may concern:

Be it known that I, PATRICK FORD, a citizen of the United States, and a resident of the city of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Methods for Excavating Rock Tunnels; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This is an improvement on my invention method for tunneling through rocks, for which application for United States patent was filed on the 26th day of December, 1905, Serial No. 293,432 and in which the excavation was performed by first driving a bottom heading and then casting down the material from the roof of the tunnel and utilizing the muck pile as a guard or shield for the muckers and permitting the drilling, blasting and mucking to proceed continuously without any crew endangering or interfering with any other.

It frequently happens that the rock or the material through which the tunnel is to be driven is not of such a firm nature as to be safely self supporting, particularly when tunnels of great width are to be driven, it is also important to provide an air line for the drills, and a pump line incapable of being injured by the falling rocks which form the muck pile.

The object of this invention is to provide an improved method for driving through rock especially multiple track tunnels or those of considerable width and those where the rock is of such a nature as not safely to support itself while the heading is being driven.

It is also an object of this invention to afford an air line for the drillers and a pump line leading beyond the muck pile whereby the falling material from the roof can in no wise shut off the supply of air for the tools or interfere with the drainage.

The invention consists in the matters hereinafter described and more fully pointed out and defined in the appended claims.

In the drawings: Figure 1 is a transverse section of a tunnel showing the bottom heading and the method of arranging the drill holes both to cast down the roof and to throw out the supporting temporary rib. Fig. 2 is a section on line 2—2 of Fig. 1. Fig. 3 is a section on line 3—3 of Fig. 1. Fig. 4 is a view similar to Fig. 1 but showing a wall or temporary rib adapted to support the roof of the heading. Fig. 5 is a section taken on line 5—5 of Fig. 4. Fig. 6 is a section taken on line 6—6 of Fig. 4. Fig. 7 is a longitudinal section of the tunnel taken along one side thereof and showing the air and pump line. Fig. 8 is a transverse section of

the tunnel showing the same after the top and temporary rib have been cast down to form the muck pile.

As shown in the drawings A indicates the rock to be tunneled and B the bottom heading. This heading in narrow tunnels is usually constructed for the entire width of the tunnel and for a height sufficient for the men to work advantageously.

C indicates the rock above the bottom heading and extending to the roof line of the tunnel, D indicates a laterally disposed temporary rib of the rock to be excavated and which is left to support the roof while driving the bottom heading when the tunnel is of such a width or the material excavated is of such a nature as not safely to be self sustaining for the entire width of the tunnel. The bottom heading may of course be constructed in any suitable manner and having constructed the same either for the entire length of the tunnel or inwardly to an air shaft, the rock to the roof line and the temporary rib D are drilled for blasting and for this purpose a drill hole *c* is provided which extends along the rib wall and slightly above the arch of the roof at the rib wall, at the temporary rib D a drill hole is provided which extends also above the arch of the roof indicated by *c'* adjacent the last named drill hole are drill holes which converge toward the top and indicated by *c*², *c*³ and intermediate the latter of said holes and drill hole *c* at the rib wall are holes *c*⁴, *c*⁵. All of said holes incline forwardly at the inner end toward the mouth of the tunnel.

Beyond the drill holes *c'* and also at their inner ends and inclining forwardly toward the mouth of the tunnel are drill holes *c*⁶, *c*⁷, *d*, *d'*, *d*², *d*³, *d*⁴, *d*⁵, which extend through the temporary rib D and slightly beyond the main rib wall. Of said holes those indicated by *c*⁶, *c*⁷, *d*, *d'* incline upwardly and are dry holes while the holes *d*², *d*³, *d*⁴, *d*⁵, are wet holes and inclined downwardly and forwardly at their inner ends, the hole *d*⁴ extends slightly below the grade line at the foot of the rib wall, and the hole *d*⁵ extends below the grade line at or near the middle of the temporary rib D.

In throwing or casting down the roof and temporary rib, the order in which the holes are shot of course depends on the firmness of the material as will also the amount of charge. Ordinarily the holes *c*, *c'*, *c*², *c*³, *c*⁴, *c*⁵, may be fired simultaneously after which and almost immediately following the holes *c*⁶, *c*⁷, *d* to *d*⁵ inclusive are fired simultaneously thus throwing the muck inwardly and downwardly owing to the forward inclination of the inner ends of the holes. In some cases all the holes may be shot at one time in others the central holes *c*², *c*³, *c*⁴ are shot first.

In the construction shown in Figs. 4 to 8 inclusive in which a wide tunnel is indicated a central temporary rib or wall E is left and in this are provided drill holes

inclined inwardly and downwardly indicated by c , the rock above the under heading is drilled to provide lateral drill holes c along the wall or rib and which extend at their inner ends forwardly and above the roof line of the tunnel as before described, at the center are provided converging drill holes c^2 and intermediate the drill holes c and c^2 are drill holes c^4 and c^5 such as before described with reference to Fig. 1.

In shooting the central temporary rib or wall is usually shot first or simultaneously with a part of the roof holes, the central roof holes c^2 , c^4 may be shot simultaneously with the holes c in the supporting wall E and the laterally disposed roof holes later, in any event owing to the forward inclination of the holes and the arrangement thereof the material is thrown forwardly and downwardly affording a high muck pile M , as shown in Figs. 7 and 8.

For the purpose of protecting the supply of air for the tools of the workmen an air line F of metallic pipe, is connected to a suitable pump or compressor at any convenient location beyond the workmen, and extends along one of the rib walls and is of course connected at convenient points in its length by suitable couplings f at suitable distances apart which provide connection for the air pipes or hose which will enable the air to be taken therefrom as may be desired.

The pump line G is also as shown a strong wrought pipe which lies between the air line F and the rib wall lying closely against the latter and which is extended inwardly as the bottom heading is constructed and through which all water is removed from the working. When constructed and arranged as described it is obvious that the falling muck cannot injure either pipe or in any case cut off the supply of air for the drillers who are usually at work some distance beyond the blasters nor can it interfere with the operation of the pump line which thus enables the heading to be kept free from water at all times and which permits the drillers to work continuously without reference to the blasting or the removal of the muck and inasmuch as the bottom heading is usually opened at both ends the draft of air created therethrough serves to carry all smoke from the tunnel rapidly and along the roof thus the workers are always sure of fresh air. Having thrown down the muck the same is usually removed by power shovels S operated by compressed air from the air line and moving upon suitable tracks, whereby the mucking is rapidly accomplished and the muckers are always protected by the muck pile. Of course the arrangement and numbers of holes may vary with nature of the rock, and various details may be modified without departing from the principle of my invention.

I claim as my invention:

1. The method of excavating rock tunnels comprising first constructing an under heading for the length of the tunnel and then arranging the air and the pipe lines close to the wall of the heading then throwing down the material from the roof of said tunnel into said heading and operating at either or both ends of the tunnel.

2. The method of excavating rock tunnels comprising first constructing an under heading for the length of the tunnel and leaving at points supporting ribs of rock and then throwing down the material from the roof of said tunnel and said supporting ribs into said heading and operating at either or both ends of the tunnel.

3. The method of constructing rock tunnels embracing first constructing a heading of the length of the proposed

tunnel and of less width and of a height convenient for the operation of the workmen, then casting down the material from the top of the heading to the roof line and from the remaining rib and removing the same by means of power shovels.

4. The method of constructing rock tunnels embracing first constructing an under heading of a length to reach an air connection and of less width than the proposed tunnel and of a height convenient for the operation of the workmen, then casting down the material to the roof line and to complete the width at the bottom and removing the same by means of power shovels.

5. The method of constructing rock tunnels, embracing first constructing an under heading for a length to communicate with an air connection and of a width sufficient for convenience of the muckers then throwing down the superposed rock and that at the side of the heading by successive shots to complete the full width of the tunnel and utilizing the muck pile thus formed as a guard for the muck men thereby enabling them to work continuously and independent of the operation of drilling and blasting crews.

6. The method of constructing rock tunnels, embracing first constructing a bottom heading of a convenient width for operation and in length extending to any air supply, then drilling and casting the superposed material downwardly and forwardly and the material at the side of the heading inwardly and forwardly then blasting to throw the material forwardly and downwardly forming a muck pile thus affording a shield for the muck men whereby the drillers at all times are unimpeded by the accumulation of muck.

7. The method of constructing rock tunnels embracing constructing an under heading along one side the proposed tunnel, then drilling upwardly from the heading to provide forwardly inclined holes and inwardly converging holes at each side the center, then blasting to throw the material forwardly and downwardly forming a muck pile thus affording a shield for the muck men, whereby the drillers at all times are unimpeded by the accumulation of muck.

8. The method of constructing rock tunnels consisting in first constructing an under heading along one wall and inwardly to air and wherein successive shots are arranged to throw the material forwardly affording a clean or true rib wall and roof, next beginning at the outer end of said heading and drilling the superposed rock to provide holes inclining forwardly along the rib and the central holes converging at their inner ends and blasting and removing the material above the heading.

9. The method of constructing rock tunnels comprising first constructing an under heading inwardly to air and along one rib of the proposed tunnel, then throwing down the roof and later the wall to the other rib thereby forming a muck pile and utilizing the muck pile as a shield to protect the mucking crew and utilizing power shovels to remove the muck.

10. The method of constructing rock tunnels by first constructing a bottom heading and inwardly to air and along one rib of the tunnel then drilling the roof to afford central inclined converging holes and intermediate rib holes and blasting down the roof in one or more operations or charges then blasting the remaining material from heading to rib.

11. The method of constructing rock tunnels comprising first constructing an under heading along one rib for a part of the width of the tunnel and inwardly to air, then drilling the roof from the heading to slightly above the tunnel roof line, to afford central converging holes, intermediate holes of less convergence extending above the roof and non-converging rib holes, all of said holes inclining forwardly at their tops and a distance from the front of the mass dependent on the nature of the rock and drilling the side of the heading inwardly to the remaining rib, then shooting said holes in the order before named, and removing the muck by means of power shovels.

12. The method of constructing tunnels comprising constructing an under heading of less width than the tunnel and inwardly to air and along one rib wall drilling a plurality of forwardly and inwardly inclined holes in the remaining wall of the other rib and in the superposed ma-

terial and shooting the charge in said holes thereby throwing the material downwardly inwardly and centrally to form a muck pile to act as a shield for the muckers.

13. The method of tunneling comprising first constructing an under heading inwardly to air, then establishing protected means along one rib of the heading to conduct compressed air inwardly, drilling the side rib and to the roof above the heading then throwing down the muck at the rear of the drillers and permitting the drillers and blasters to work on one side the muck pile, and the muckers on the other simultaneously.

14. The method of constructing rock tunnels comprising first constructing an under heading to air, drilling inclined holes to or slightly below grade, to the wall and to the roof line in the remaining material to be excavated and blasting and throwing the material between the drillers and muckers thus drilling, blasting and mucking simultaneously.

15. The method of constructing tunnels by first constructing an under heading the entire length of the tunnel or inwardly to air, establishing a metal air line for the drillers on the floor, drilling forwardly inclined holes in the material above and at the side of the heading to or slightly beyond the roof and rib and some of the holes converging, blasting closely behind the drillers and throwing the muck rearwardly to protect the muckers and mechanically removing the muck by any suitable mechanism operated from the air line.

16. The method of constructing rock tunnels by first constructing an under heading to air, establishing a metal air pipe along one rib of the heading from the outer end of the tunnel to supply pressure for the tools and for mucking, drilling and throwing the material from above and the side of the heading rearwardly from succeeding blasts and continuously removing the muck behind the blasters by mechanism operated by pressure from the air line.

17. The method of constructing tunnels by first constructing an under heading inwardly to air, providing a

strong metal air pipe line to supply power, piping from either or both ends of the tunnel inwardly for the removal of water, then drilling and casting down and mucking the material.

18. The method of constructing rock tunnels by first constructing an under heading for the entire length of the tunnel, laying metallic pressure supply pipes and a metallic water pipe along one rib of the heading, drilling holes inclined toward each end of the tunnel in the wall above and to the side of the heading and operating from both ends and intermediate the ends, blasting and throwing the muck toward each end of the tunnel away from the unblasted part and removing the muck from both ends of the tunnel by shovels operated from the pressure pipe.

19. The method of constructing rock tunnels comprising first constructing an under heading inwardly to air and of less width than the proposed tunnel, establishing a metallic pressure pipe above the floor, drilling forwardly inclined holes in both the material above and at the side of the heading, throwing down the material utilizing gravity and forming a muck pile and affording a shield behind which the muckers work uninterruptedly and unimpeded and utilizing the pressure pipe to afford power for drillers and muckers.

20. The method of constructing rock tunnels by first constructing an under heading, then providing means to conduct pressure to the drills the length of the heading and which is unaffected by the blasting, providing means to draw the water from the tunnel regardless of the muck pile, then drilling and throwing the muck from the roof downwardly and outwardly from subsequent blasts and removing the muck by shovels operated from said pressure line.

In testimony whereof I have hereunto subscribed my name in the presence of two subscribing witnesses.

PATRICK FORD.

Witnesses:

C. W. HILLS,
WM. C. SMITH.