No. 642,049. Patented Jan. 23, 1900.

L. E. MILLER.

PROCESS OF MINING IN FROZEN GROUND.

(Application filed Aug. 7, 1899.)

(No Model.) 2 Sheets—Sheet 1.

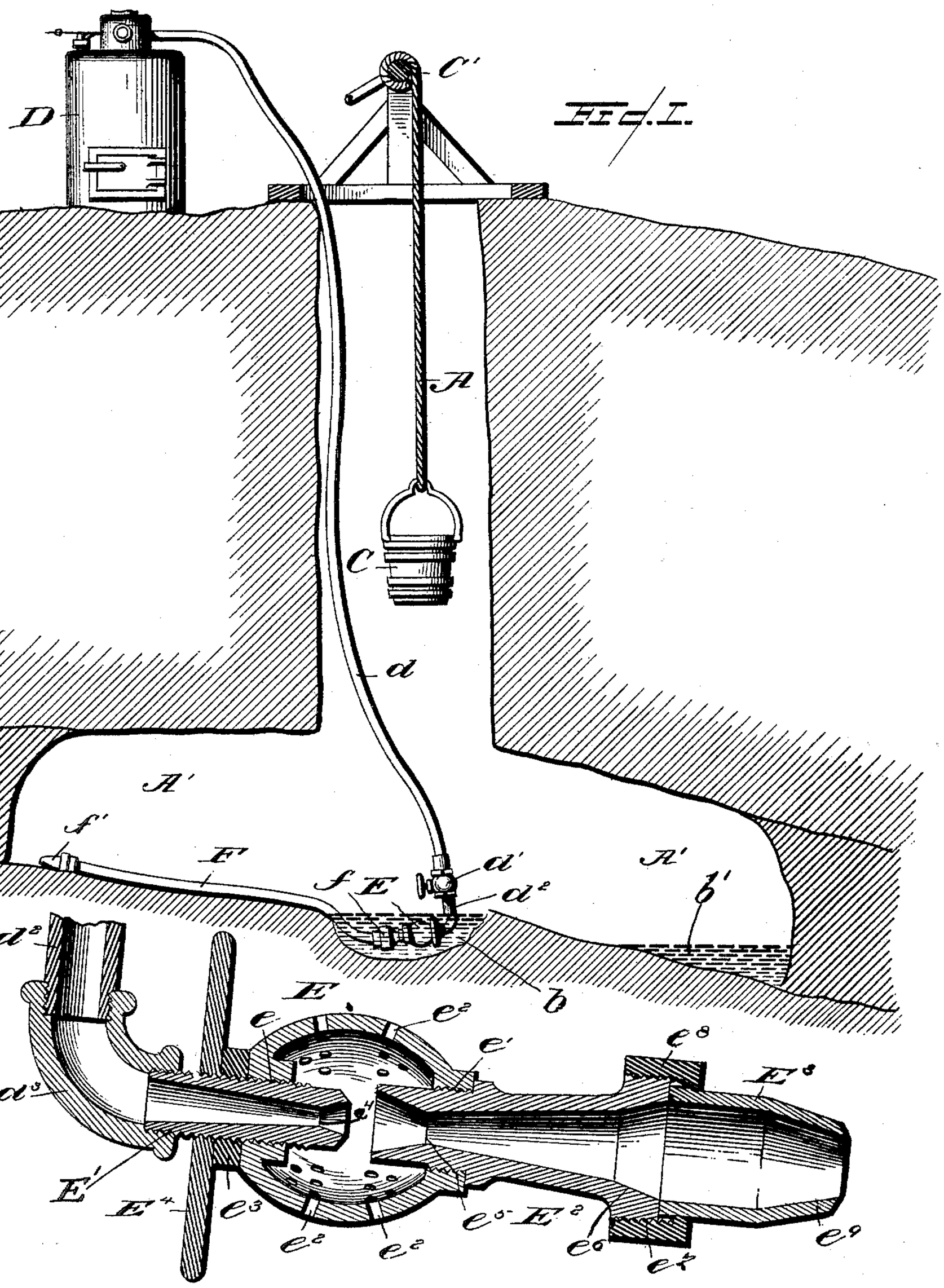

Fig. 1.

Fig. 2.

Witnesses
L. C. Hills
J. D. Kingsbury

Inventor
Louis E. Miller,
By Whitaker Prevost
Attorneys.

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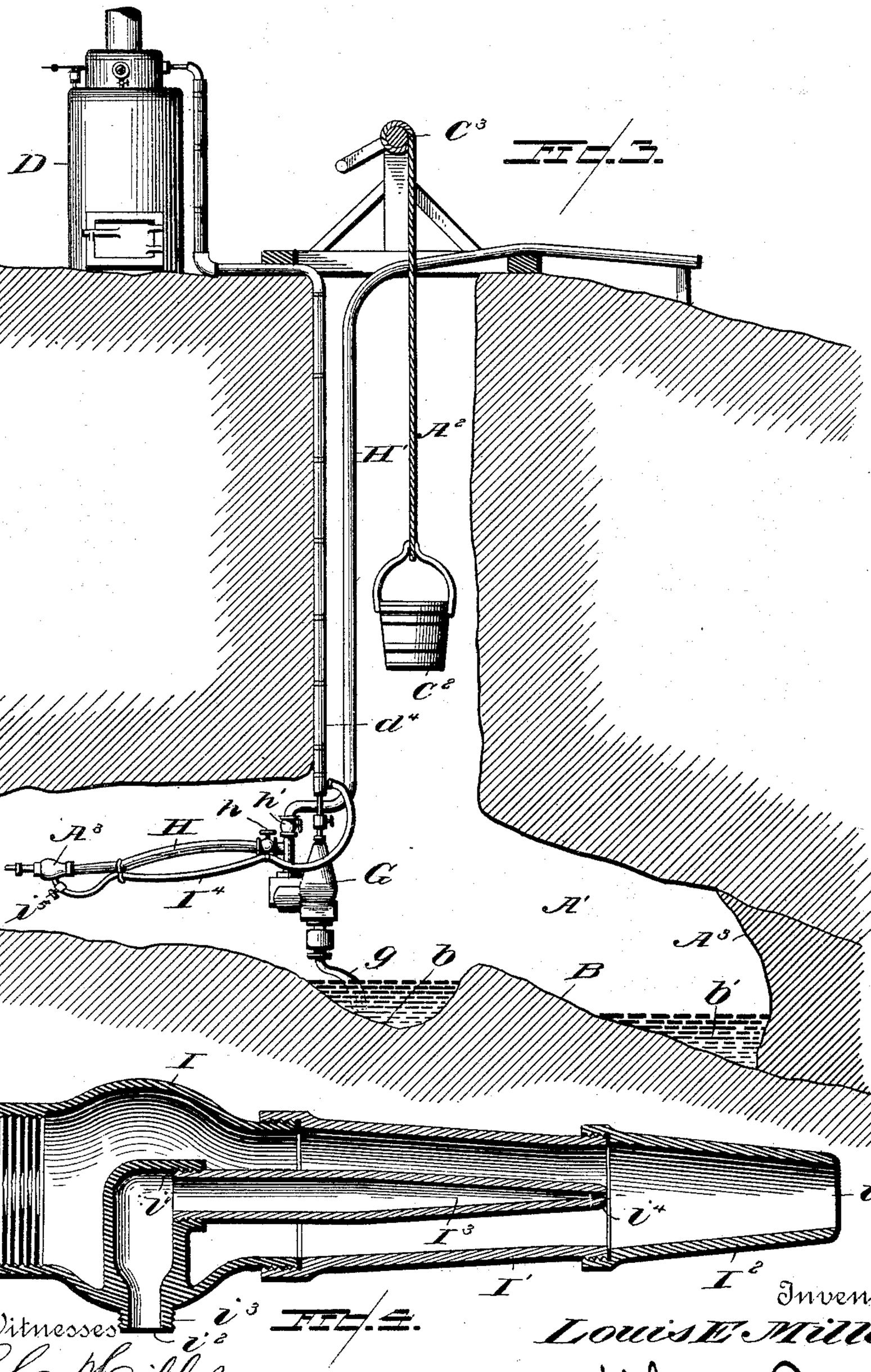

FIG. 3.

FIG. 4.

Witnesses
L. C. Hills.
J. D. Kingsbury

Inventor
Louis E. Miller;
By Whitaker & Pierce
Attorneys

UNITED STATES PATENT OFFICE.

LOUIS E. MILLER, OF DAWSON, CANADA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE ELLIOT MACHINE AND MINING COMPANY, OF NEW JERSEY.

PROCESS OF MINING IN FROZEN GROUND.

SPECIFICATION forming part of Letters Patent No. 642,049, dated January 23, 1900.

Original application filed May 27, 1899, Serial No. 718,549. Divided and this application filed August 7, 1899. Serial No. 726,445. (No model.)

To all whom it may concern:

Be it known that I, LOUIS E. MILLER, a citizen of the United States, residing at Dawson, Canada, have invented certain new and useful Improvements in Processes of Mining in Frozen Ground; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention is an improvement in processes of mining in frozen ground; and it consists in the novel features hereinafter described, reference being had to the accompanying drawings, which illustrate two forms of apparatus which I have contemplated using in carrying out my improved process; and my invention is fully disclosed in the following description and claims.

Referring to the drawings, Figure 1 represents a sectional view of a mining shaft and drift, showing one form of apparatus for carrying out my improved process. Fig. 2 is a sectional view, on an enlarged scale, of a steam-ejector shown in Fig. 1. Fig. 3 is a view similar to Fig. 1, showing a modified form of apparatus for carrying out my process; and Fig. 4 is an enlarged sectional view of a steam-ejector nozzle shown in Fig. 3.

This application is a division of my former application, Serial No. 718,549, filed in the United States Patent Office May 27, 1899.

In certain parts of North America where mining operations are carried on, principally for gold and other precious metals, the ground is frozen to a great depth, and it is impossible to mine such frozen ground economically by ordinary methods.

The object of my invention is to provide a process for sinking a vertical shaft to the bed-rock, above which the pay streak or strata containing the precious metals are usually located, and for running drifts laterally from said shaft above the bed-rock and removing the gravel and earth containing the precious metals. In carrying out my process I form a sump or pocket for containing a small pool of water, and I convey steam from the surface of the ground into the shaft or drift, cause it to act upon the water in the sump or pocket to heat portions of the same to a considerable temperature, and force it with high speed and force against the frozen ground, thereby melting the frost therein and disintegrating the ground. The solid material is then removed by means of a bucket or other suitable conveyer and conveyed to the surface, while the water returns to the sump. I thus establish a circulation of the water within the shaft or mine and use the same water over and over again without removing it from the mine except when the amount of water becomes augmented by the condensation of steam and the melting of the frost in the ground to such an extent as may require a portion of the water to be drawn off at suitable intervals to prevent the mine from becoming so full of water as to inconvenience the operators working therein.

In the form of apparatus for carrying out my process which I have illustrated in Fig. 1, A represents a vertical shaft which has been sunk through the frozen ground, and A′ A′ represent the lateral drifts above the bed-rock B. In Fig. 1 the mine is shown as having been sunk to the bed-rock and the apparatus hereinafter described is being employed in removing the pay-gravel from the drift, the material being removed by means of a bucket C and windlass C′, as shown in the drawings, or other suitable form of conveyer. The pool of water may be contained in a sump *b*, blasted out of the bed-rock, as shown, or where the bed-rock is inclined a pocket may be formed in one of the drifts to contain water for carrying out my process, as indicated at *b′* in Fig. 1. D represents a steam-generating boiler located above the surface of the ground and provided with a steam-supply pipe *d*, which extends down into the mine, where it is provided adjacent to its lower end with a cut-off cock *d′*, by means of which the supply of steam can be controlled. E represents an ejector which I employ in this form of apparatus for imparting heat and motion to the water in the pool. This ejector is shown

in detail in Fig. 2. E represents the main body of the ejector, which is hollow and preferably substantially spherical in form. It is provided with two opposite threaded apertures e e' and with means for admitting water to its interior, consisting in this instance of a series of apertures e^2. E′ represents the steam or jet tube, which is externally threaded and is screwed into the aperture e, so that it can be adjusted longitudinally in said aperture by rotating it, and e^3 is a jam-nut surrounding said steam or jet tube for securing it rigidly in its adjusted position. The tube E′ is provided with a longitudinal passage, which decreases in size from its outer end to a point adjacent to its inner end, (indicated at e^4,) from which point the said passage widens abruptly to the inner end of the tube. E^2 represents the discharge-tube of the ejector, which has a portion extending into the hollow body E in line with the steam or jet tube E′, said portion being externally threaded and screwed into the aperture e' of the hollow body, as shown. The tube E^2 is provided with a longitudinal passage, which at the inner end of the tube is of considerably greater diameter than that of the jet-tube at its inner end and decreases rapidly in size to a point indicated at e^5, from which said passage increases in diameter to a point e^6, adjacent to its outer end, and then widens rapidly to the outer end of the discharge-tube, as shown. The outer end of the discharge-tube E^2 is provided externally with threads, as shown at e^7, which are adapted to receive a standard pipe-coupling of the proper size.

When the stream of heated water is designed to be discharged close to the ejector, I provide the discharge-tube with a short nozzle E^3, as shown in Fig. 2. This nozzle is provided with a screw coupling-ring e^8, by means of which it is attached to the discharge-tube E^2. The nozzle is provided with an internal passage, the rear portion of which is of the same diameter as the outlet of the discharge-tube E^2, the outer portion of said passage being contracted, as shown at e^9.

E^4 represents a supporting disk or wheel provided with a central aperture, which engages the steam or jet tube E′. The object of this disk is to hold the main body of the ejector above the bottom of the sump or pool to prevent gravel and sediment from entering the same and also to incline the nozzle E^3 in a downward direction, so as to cause it to eject the water against the sides of the sump when said nozzle is used. The jet-tube E′ is connected with the steam-pipe through the valve d' by means of a pipe d^2 and elbow d^3.

In digging a vertical shaft through frozen ground a sump or pocket is formed to contain the amount of water necessary to submerge the ejector E, which is connected with the steam-boiler, as heretofore described, and steam is then admitted to the ejector. The steam passing in through the jet-tube E′ condenses, forming a partial vacuum, which draws water into the hollow main body. The water is heated by contact with the steam, and the heated water is discharged through the discharge-tube E^2 and nozzle E^3 with great force against the sides of the sump or pocket, melting the ice in the frozen ground and disintegrating the soil, which is removed by shovels. By continually manipulating the ejector so as to direct the heated stream of water against different portions of the sides of the pockets and removing the soil as fast as it is loosened up the shaft can be sunk very rapidly to the bed-rock, after which the bed-rock will be provided with a sump, as indicated at b, to contain the pool of water, or the water may be allowed to collect at the lowest point of the shaft or a drift thereof, as indicated at b', if the formation of the bed-rock favors such a plan. In excavating lateral drifts the nozzle E^3 will be removed from the discharge-tube E^2, and a length of hose F will be attached by means of an ordinary coupling f, as indicated in Fig. 1, the hose F being provided with a discharge-nozzle f' to direct the current of heated water against the sides of the drift.

The jet or steam tube E′ is capable of adjustment longitudinally toward and from the discharge-tube E^2, as before stated, and this adjustment enables the operator to control the speed or velocity of the stream of water and also its temperature. By adjusting the jet-tube closer to the discharge-tube a smaller amount of water will be taken into the discharge-tube in proportion to the steam used, and the water will be delivered, in consequence, with greater velocity and at a higher temperature. By adjusting the steam or jet tube outwardly a greater amount of water will be taken in between the jet-tube and the discharge-tube, with the result that the stream of water discharged will be at a lower temperature and delivered with less velocity. It is important that the operator should be thus enabled to regulate the temperature of the stream discharged, as I find that in using a stream at too high a temperature a mist or fog is produced in the mine, which interferes with the operators, while no fog is produced if the water is not above a certain temperature. It will be understood that the solid material thus softened and disintegrated will be filled into buckets and elevated to the surface of the ground for suitable treatment to remove the precious metal, while the water will return to the sump or pool and is used over and over again, the water giving up its heat in melting the frozen ground and returning cold to the pool. In my process the water is not taken out of the mine ordinarily. Owing to the melting of the ice in the frozen soil and the condensation of the steam it occasionally becomes necessary to remove a portion of the water from the pool to prevent it from extending over the bottom of the mine.

This can be conveniently done by providing the discharge-pipe of the ejector with a hose (not shown) similar to the hose F, long enough to extend to the top of the mine, and blowing out a portion of the water by means of the steam passing through the ejector, or the water may be removed at intervals in any other desired way.

In Fig. 3 I have illustrated a modified form of apparatus for carrying out my process, which is adapted particularly for use in operating in drifts at a considerable distance from the sump or pool. In this drawing, A^2 represents the vertical shaft, A^3 A^3 the horizontal drifts, and B′ the bed-rock, provided with a sump *b* or a pocket *b′* to contain the water. C^2 represents the hoisting-bucket, and C^3 the windlass. D′ represents the boiler, and d^4 the steam-supply pipe leading down into the mine, which pipe will preferably be covered with asbestos or other non-conducting covering, as indicated in the drawing. At the bottom of the shaft I provide a steam vacuum-pump of any of the well-known types of these devices in which water is drawn from a supply and forced out by the direct action of a current of steam. In the present instance I have illustrated at G a vacuum-pump which is known as the "pulsometer;" but I may use other forms of steam vacuum-pumps. The construction of these steam vacuum-pumps being well known, I will not particularly describe the construction of the same, merely stating that the steam is brought into contact with the water and not only forces it out of the pump, but imparts to it a certain amount of heat from the steam. A pipe *g* extends from the pump G to the sump or other cavity containing the pool of water, and a hose H is connected with the pump G for delivering the stream of partially-heated water under the pressure produced by the action of the pump. The outer end of the hose H is provided with an improved ejector-nozzle I. (Illustrated in detail in Fig. 4.) This nozzle comprises the main body I, one end of which is adapted to be engaged by the hose-coupling on the outer end of the hose H, and the other end is provided with a tapering discharge-tube I′, the smaller end of which is provided with a smaller tapering tube I^2, having a reduced discharge-aperture *i*. I prefer to make this nozzle I in sections in the manner shown in Fig. 4 to facilitate the construction and assembling of the parts. The interior of the main body I is provided with a steam-compartment *i′*, provided with a steam-inlet passage i^2, extending through a threaded nipple i^3, projecting from the casing I. The compartment *i′* is provided with a threaded aperture in line with the axis of the nozzle, into which is screwed a steam or jet tube I^3, which has a longitudinal passage therethrough, terminating in a reduced delivery-aperture i^4 at some little distance from the discharge-aperture of the nozzle. The nipple i^3 is connected by a pipe I^4 (see Fig. 3) with the steam-supply pipe d^4, so that live steam under the initial boiler-pressure is admitted into the nozzle and discharged from the jet-tube into the stream of partially-heated water which is being forced through the nozzle by the steam vacuum-pump, and the live steam is thus admitted to the water immediately before it leaves the nozzle. The water being already under motion and partially heated by reason of the action of the steam vacuum-pump is discharged from the nozzle in a highly-heated condition and with great force, and thus rapidly melts and disintegrates the frozen earth. The earth is then removed, as before described, and the water returns to the sump or pool to be used over again.

The steam-supply pipe I^4, leading to the nozzle I, is provided with a controlling-valve i^5, by means of which the operator can control the supply of steam, and thus regulate the temperature of the stream of water discharged to prevent the formation of a mist or fog within the mine. I also provide the steam-pump G with a hose or pipe H′, leading to the surface of the ground, as shown, said pipe being provided with a valve *h′*, and the pipe H, leading to the nozzle I, is also provided with a similar valve *h*. By closing the valve *h* and opening valve *h′* the surplus water in the sump or pool can be forced out of the mine at intervals when necessary.

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

1. The herein-described process of mining in frozen ground which consists in forming a pool of water in the shaft or mine, conveying steam into the shaft or mine and bringing it in contact with the water from said pool to heat the water and force it into contact with the frozen soil, to disintegrate it, conducting the water back to said pool and removing the disintegrated soil, whereby a circulation of the water is established within the shaft or mine and the continuous raising of the water to the surface of the ground is obviated, substantially as described.

2. The herein-described process of mining in frozen ground which consists in forming a sump or depression in the shaft or mine to contain a pool of water, conveying steam to the bottom of the shaft or mine, mingling the steam with the water from the pool to heat it, forcing said heated water into contact with the frozen soil, to disintegrate the soil, conveying the water back into the sump or depression, and removing the disintegrated soil from the shaft or mine, whereby a circulation of the water is established within the shaft or mine, and the continuous raising of the water to the surface of the ground is obviated, substantially as described.

3. The herein-described process of mining in frozen ground which consists in forming a sump or depression in the shaft or mine to contain a pool of water, conveying steam to the bottom of the shaft or mine, drawing the water from the pool and forcing it into con-

tact with the frozen soil to disintegrate it, admitting steam into the water immediately before it is discharged against the frozen soil, conducting the water back to the sump or depression, and removing the disintegrated soil, whereby a circulation of the water is established within the shaft or mine and the continuous raising of the water to the surface of the ground is obviated, substantially as described.

In testimony whereof I affix my signature in the presence of two witnesses.

LOUIS E. MILLER.

Witnesses:
ROBT. W. TAYLOR,
R. D. MCELROY.