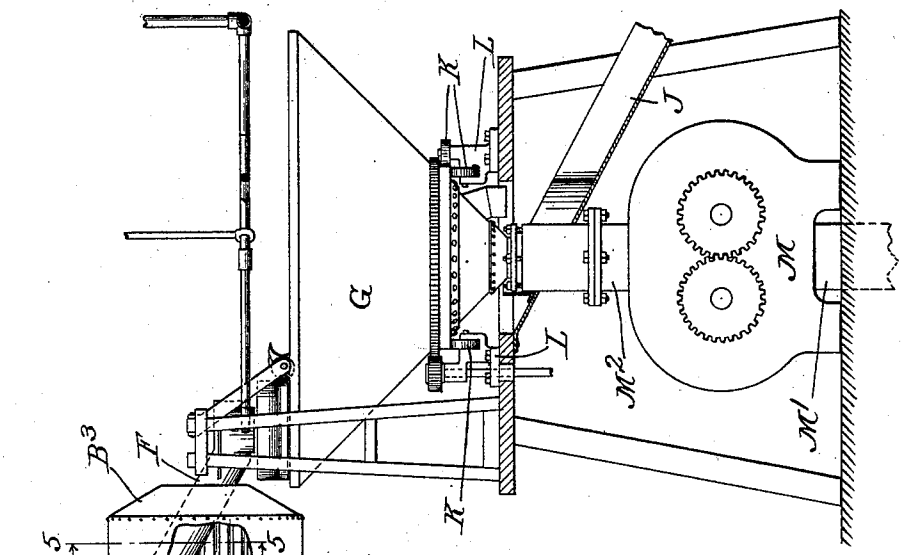
No. 673,425. Patented May 7, 1901.

G. A. DUNCAN & F. H. BEACH.

METHOD OF TREATING PRECIOUS METAL BEARING ORES.

(Application filed June 11, 1900.)

(No Model.) 2 Sheets—Sheet 1.



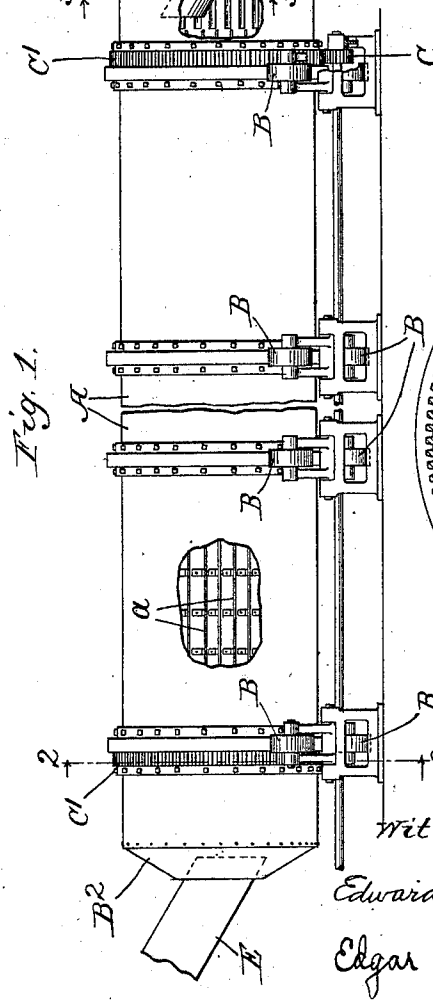


Fig. 1.

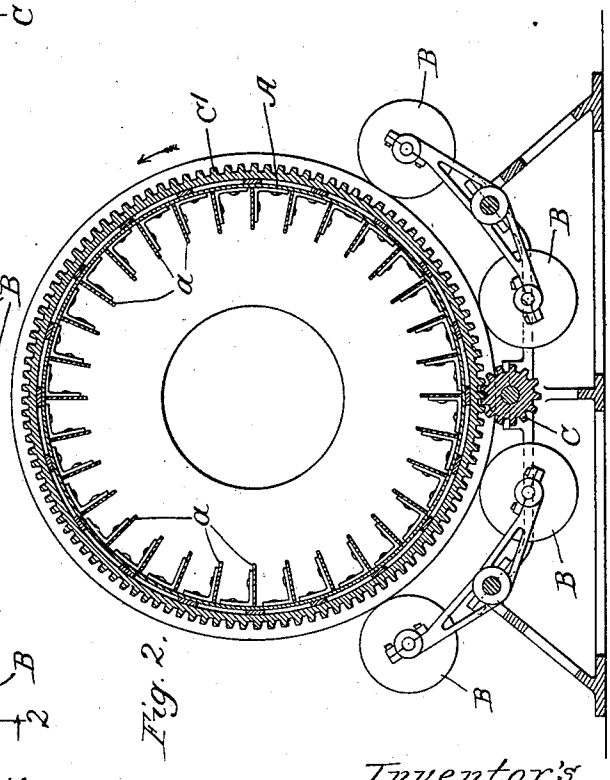


Fig. 2.

Witnesses.
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Edgar L. Conant

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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Fig. 3.

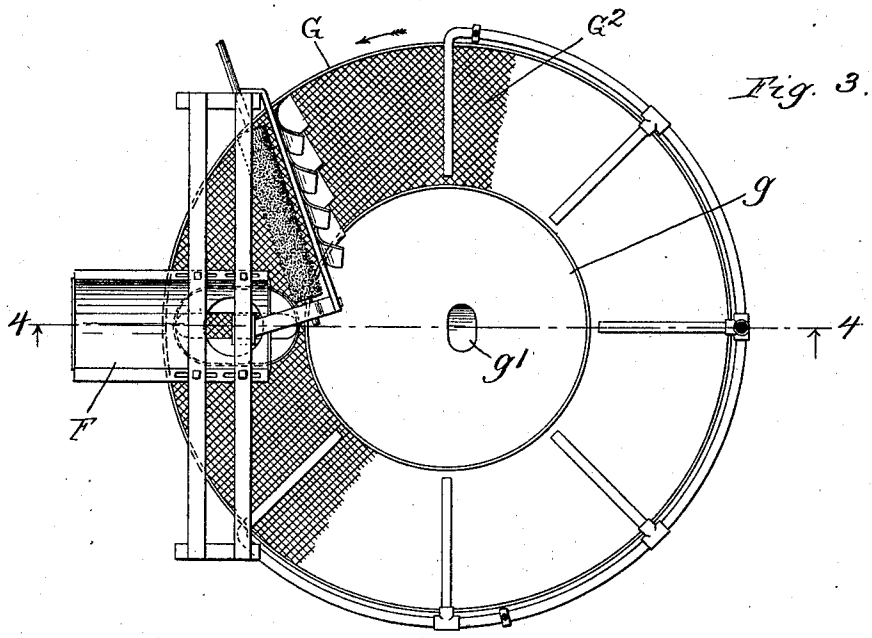


Fig. 4.

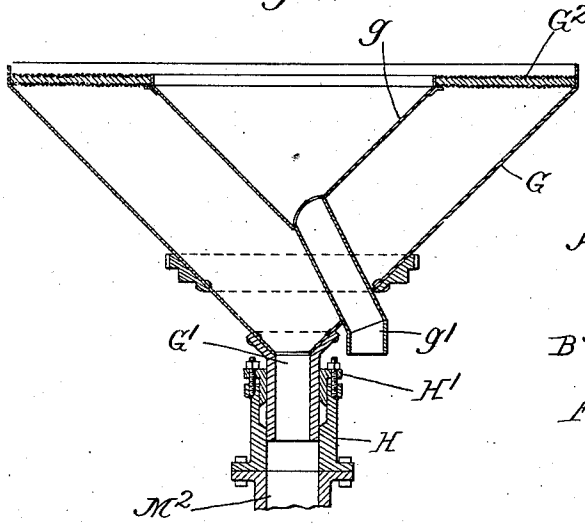
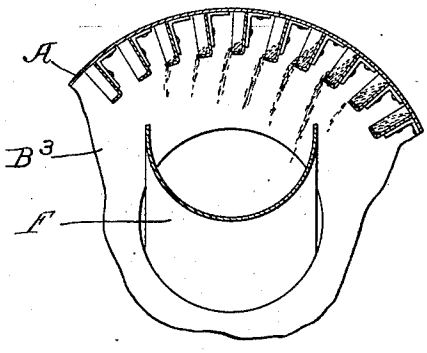


Fig. 5.



Witnesses.
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UNITED STATES PATENT OFFICE.

GUSTAVUS A. DUNCAN, OF SALT LAKE CITY, UTAH, AND FREDERICK H. BEACH, OF BATAVIA, ILLINOIS.

METHOD OF TREATING PRECIOUS-METAL-BEARING ORES.

SPECIFICATION forming part of Letters Patent No. 673,425, dated May 7, 1901.

Application filed June 11, 1900. Serial No. 19,774. (No specimens.)

To all whom it may concern:

Be it known that we, GUSTAVUS A. DUNCAN, residing at Salt Lake City, county of Salt Lake, State of Utah, and FREDERICK H. BEACH, residing and having post-office address at Batavia, Kane county, State of Illinois, citizens of the United States, have invented certain new and useful Improvements in Methods of Treatment of Precious-Metal-Bearing Ores, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

Our invention relates to the treatment of ores bearing gold and silver or other precious metals which are susceptible of being taken up in solution by a liquid solvent, and particularly to a treatment such as the cyanid treatment of gold-bearing ores, in which the action of the solvent on the precious metal is hastened by causing the contact of the solvent with the metal to occur in the presence of air.

It consists in a method of handling, manipulating, and forwarding the ore and solvent by which continuous feed and delivery of the same is maintained and substantially continuous contact and intermixture of air with the solvent in the presence and contact of the ore is effected and maintained during a sufficient period to cause the precious metal to be thoroughly dissolved and a continuous delivery of the mingled ore and metal-bearing liquor is made to a continuously-operating separator from which a continuous delivery is made of the metal-bearing liquor to one destination and the impoverished ore or tailings to another.

In the practice of our invention we reach the best results in respect to obtaining and maintaining continuous contact of the liquor and the ore and the continuous presence of air throughout such contact at all points where the liquor is in active contact with the metal by continuous agitation of both the liquor and the ore in a chamber whose capacity is very much greater than the volume of liquor and ore at any time contained therein, such smaller volume of liquor and ore being nevertheless kept in such constant movement through the whole space of the chamber that the latter is at all times substantially fully occupied by a homogeneous volume of intermixed liquor, ore, and air. We have ascertained that the mere agitation of the ore and liquor, even by the injection of air thereinto, effects very little hastening of the process, the air having a tendency to pass off directly upward in bubbles or jets, which come in contact in their passage with only a very small proportion of the particles which are under the action of the liquor, and also that very little is gained by simply moving the ore back and forth between the liquor and the air, because in that action the drainage of the liquor from the surface of the ore, when it is lifted out of the former, prevents the contact of the air from producing any considerable effect. The means and method of agitation, therefore, employed in the practice of our invention must be such as to cause both the liquor and the ore to be together dispersed throughout a relatively large volume of air and maintain thus dispersed while both the liquor and the ore are kept in movement, so that a constant change of contact may occur.

The second step in the method of treatment which constitutes our invention may be performed by any continuously-operating screen or filter by which the stream of intermingled ore and liquor charged with the dissolved precious metal may be received and conducted away from the point at which it is received while filtration occurs, so that at the end of any sufficiently-extended course the impoverished ore or tailings on the screen having been meanwhile, during a portion of the course, exposed to proper washing will be practically deprived of its values and may be delivered in a continuous stream to a dump or a conveyer which may carry it to the dump, while the liquor, having filtered through the apparatus, shall be received in a proper conduit and conducted away for further treatment for the purpose of extracting the metal therefrom.

The mechanism which we have found most effective in the practice of our invention is shown in the drawings, in which—

Figure 1 is a side elevation of a horizontal hollow cylinder and means for rotating it, the shell being partly broken away to disclose the interior. Fig. 2 is a section of said

cylinder at the line 2 2 on Fig. 1. Fig. 3 is a plan of a filtering device or separator by which the intermingled ore and liquor delivered from the horizontal cylinder is received and the liquor separated from the impoverished ore or tailings. Fig. 4 is a vertical axial section at the line 4 4 on Fig. 3. Fig. 5 is a detail section at the line 5 5 on Fig. 1.

The cylinder A is supported on rollers B B, journaled in suitable frames, and is rotated by gears C C, meshing with the gear-rims C′ C′, which are rigid with the cylinder, on the outside thereof. The heads B^2 and B^3 of the cylinder are preferably flared outward at the center, and they have each a central aperture for the introduction and discharge of the material, which are of such size as to afford free access and circulation of atmospheric air through the cylinder while it is in operation.

E is a chute suitably supported outside of the cylinder A, at the receiving end thereof, and intruded thereinto through the central aperture in the head B^2. This chute conducts the stream of mingled ore and solvent liquor into the cylinder. A conveying or positive-feeding device may be added to the chute to render the supply positive or more uniform and less liable to clog.

The cylinder A has distributed through its entire length a multiplicity of inwardly-projecting lips, ledges, or flights *a*, preferably extending parallel with the axis of the cylinder and projecting substantially radially thereinto for a distance of about four inches.

F is a discharge-spout which is intruded into the central aperture of the head B^3 to receive and conduct out the stream of mingled ore and liquor. At its outer discharge end it overhangs the filter or separator. If convenience requires, the discharge may be into a conveyer leading to the filter or separator. This last-mentioned device consists of an annular revolving hopper or conical receiver G, which terminates at its lower end in a vertical pipe G′, by means of which it is suitably journaled in vertical bearings mounted below an inclined chute J, which is penetrated by said pipe G′. The weight of this hopper may be carried by rollers K K, journaled on a suitable standard or frame L. The hopper G is rendered annular, as described, by a smaller hopper *g*, concentric within it and connected rigidly to it and having its lower terminal extended out laterally through the wall of the hopper G, so that it may discharge exteriorly thereto onto the inclined chute J. The mouth of the annular hopper G is closed by a screen G^2, of perforated sheet metal or woven wire, cloth, or other similar foraminous material, constituting a perforated table-top or sieve onto which the stream delivered from the spout F is received as said table-top is continuously revolved. Additional filtering material may be employed whenever deemed desirable, such as powdered charcoal or fibrous or mineral substance suitable for arresting the solid material, such additional filtering substance being retained between two sheets of perforated metal, woven wire, or other fabric, as illustrated in Fig. 4. The lower end of the pipe G′ obtains its vertical bearings, as above mentioned, by extending through a stuffing-box H in the upper end of the pipe M^2, which extends rigidly from the intake-aperture of the case of a positive exhaust device M, adapted to have the liquor which filters through the perforated table-top pass through it, while by its action it produces a condition of rarefication underneath the perforated table-top to hasten such filtering action. The discharge M′ from the exhaust device M conducts the liquor to any suitable receiver or conduit for subsequent steps in the treatment necessary for the purpose of recovering the metal values therefrom.

When the stream of gold-bearing ore and the solvent liquor—as, for example, water having the proper proportion of cyanid of potassium—is discharged into the cylinder A by the chute E and the cylinder is revolved at a considerable speed, the flights *a* in their revolution carry up with them the ore and liquor, which descend in a shower from the upper side of the cylinder through the open space thereof to the lower part, where the material is again caught by the flights, and thus repeatedly and continually carried up and showered down. To some extent this result in respect to the ore would be obtained without the use of any flights, and also measurably in respect to the liquor without the flights, by sufficiently increasing the speed of the rotation of the cylinder. The purpose of the flights is merely to increase the carrying capacity of the cylinder to carry up the liquor and ore and make its carrying effect upon both the liquor and the ore more nearly equal. If, however, the cylinder be revolved slowly, so that the liquor flows off the flights back down the wall of the cylinder as the cylinder revolves, even though the ore be carried up to a considerable extent and caused to fall again into the liquor, the desired result is not attained to any considerable extent. Even if instead of the straight radial flights shown pockets be provided adapted to pick up and carry positively a quantity of the liquor and ore, still if the speed of rotation is slow the rapid result desired is not attained, because in each pocket the fragments of ore remain immersed in the liquor carried up in the pockets and the air does not obtain access to the liquor and the metal except as the pocket is slowly emptied by tipping as it is carried over, and while being carried up to this point the mineral tends to settle, so that when the pocket commences to tip the liquor is drained off of the top and the mineral subsequently discharged in bulk, thus preventing the complete exposure of the mineral, particle by particle, to the air while moistened with the liquor, as is necessary to the rapid result sought. On the other hand, if pockets are employed and a high rate of

speed of rotation is maintained still the effect is not perfectly as desired, because the liquor and ore being taken in the pockets and carried positively remain quiescent therein while they are being carried up, and throughout that period the desired action of the air is not obtained. On the other hand, with a suitable rotary speed of the cylinder and the straight flights, which do not positively (as pockets) carry the liquor and ore, but only serve to engage it with a push or blow and toss it up into the air as the cylinder revolves, the entire mass or volume of ore and liquor in the cylinder is kept practically suspended or in a state of shower in the air above the level at which the liquor and ore would otherwise stand in the bottom of the cylinder, and the liquor and ore and air become practically a homogeneous mixture, occupying the entire volume of the cylinder, each element being in constant motion and maintaining a perpetual change of contact particle with particle. In practice with a cylinder fifty-two inches in diameter a rotary speed of fifteen to twenty-five revolutions per minute, giving a circumferential speed of two hundred to three hundred feet per minute, is found to give the desired result. It will be seen that this is an essentially different thing from merely blowing or forcing air under pressure through the liquor, which while it might agitate the liquor, and to some slight extent the smaller particles of ore therein, would not cause the liquor and ore to be brought to any large extent in contact with the air, because air thus injected into liquid tends to pass through the same along the path of least resistance, and thus when one bubble or jet has opened the way all coming after tend to find and follow the same path, and thus the tendency of the air is to aggregate into constantly larger and larger jets or bubbles, so that it comes into contact with the minimum number of particles of liquid on its way through the same. On the contrary, the moistened ore in the form of sand grains each inclosed in a film of liquor and the liquor itself discharged through the atmosphere either upwardly or downwardly tends not to aggregate, but, on the contrary, to separate as the resistance of the air is encountered. A shower of sand, for example, delivered from a high point from an aperture an inch in diameter will spread over an area of many feet by the time it has reached the ground, and a jet of water issuing from a nozzle an inch in diameter will in like manner be spread over an area of many feet at a distance from the end of the nozzle. This mode of action of mingled ore and liquor which results from causing it to be moved through the atmosphere against the natural resistance of the latter, which is characterized by the tendency to disperse the particles more and more widely the longer they are thus moved, we denote by the term "showering" or "causing to move in a shower," and by that term we do not intend to limit ourselves to a downward movement, although since it is most convenient and economical to produce such showering by downward movement the steps for producing it in this manner may be specifically claimed. Our method is also distinguished from any method by which the ore is occasionally or in bulk or even frequently and in comparatively small quantities at intervals lifted out of and dropped back into the liquor, because under such circumstances the action due to the presence of the air at the point of action of the liquor on the metal occurs only during the short time during which the ore is out of the liquor while still wet therewith and only over the portion of surface which being thus wet is exposed to the air, whereas in the use of our method, the ore falling in a shower with the liquor which has been lifted with it becomes separated particle from particle, each particle being moistened with the liquor and being exposed to the air throughout its whole moistened surface, and this operation being practically continuous, the ore no sooner having fallen back to the bottom of the cylinder than it is again picked up. The action as stimulated and caused by the presence of the air is continuous and takes place under the most favorable circumstances. Furthermore, this method must be distingushed from any process or method in which the liquor only is agitated while the ore lies undisturbed, because in our method, which causes each and every piece and particle of ore to be turned over and over, the liquor in the crevices and pores is constantly changed and the metal in the ore-crevices is constantly exposed to fresh solution.

The distance to which the discharge-spout F is intruded into the cylinder determines the rate at which the liquor and ore is discharged therefrom, and this in turn determines the rate of advance of the mingled ore and liquor through the cylinder, for it will be evident that said advance is caused solely by the tendency of the liquor to seek a level, and is not, therefore, controlled by the speed of rotation of the cylinder, and the intrusion of the spout farther to cause it to take the liquid out more rapidly, tending to lower the level, will cause the material to advance more rapidly to restore the level. The independence of control which may thus be exercised over the rotary speed, on the one hand, and the rate of advance and delivery of the material, on the other hand, makes it possible with this apparatus to fully carry out our process, because the rotary speed may be made such as to result in the showering of the ore and liquor, as described, to cause complete exposure particle by particle to the atmospheric air in the cylinder, and the spout can be adjusted so as to take the liquor out only so fast, and thus cause it to advance through the cylinder only so fast, as necessary or consistent in order to keep it in the cylin-

der and exposed to the process the proper length of time to make such process effective. It will also be observed that the free access of atmospheric air to the cylinder at both ends and the large volume of air contained in it and through which the ore and liquor are dispersed relatively to the maximum quantity of ore and liquor which can at any time be therein—such maximum being the quantity which would fill it up to the lower margin of the central aperture in the head, as denoted by the dotted line X X in Fig. 2—renders the process essentially different from any process in which the liquor and ore mixture is merely agitated in a containing vessel or in a duct through which it is advanced and which is substantially fully occupied by it. It will also be manifest that it is not absolutely essential that the agitation which causes the dispersion of the ore and liquor into the air or the thorough intermixture of the air therewith should be performed within an inclosing chamber; but there is an advantage in the employment of such a chamber as the cylinder A, in that it prevents the loss by vaporization of more or less valuable elements of the solvent liquor.

We claim—

1. The method of treatment of precious-metal-bearing ores to cause the metal to be dissolved from the ore, which consists in maintaining a thoroughly-mingled condition of comminuted ore and solvent liquor by showering such mingled ore and liquor through the air.

2. The method of treatment of precious-metal-bearing ores to cause the precious metal to be dissolved from the ore, which consists in maintaining a substantially continuous supply-stream of mingled comminuted ore and solvent liquor through a chamber, and mechanically agitating the ore and liquor in such chamber and thereby causing both the liquor and ore to be showered throughout the chamber, while passing longitudinally through it.

3. The method of treatment of precious-metal-bearing ores to cause the metal to be dissolved in the ore, which consists in thoroughly mingling comminuted ore and solvent liquor in proportions suitable to produce a fluent mixture; continuously supplying such mixture at one point, and delivering it at a remote point; showering it through the atmosphere during its advance from the point of supply to the point of delivery, and maintaining free access of atmospheric air along the path of such advance.

4. A method of treatment of precious-metal-bearing ores to cause the metal to be dissolved in the ore, which consists in thoroughly mingling comminuted ore and solvent liquor in proportions suitable to produce a fluent mixture; continuously supplying such mixture at one point, and delivering it at a remote point; showering it through the atmosphere during its advance from the point of supply to the point of delivery; maintaining free access of atmospheric air along the path of advance; and independently controlling the movement of showering and the movement of advance.

5. The method of treatment of precious-metal-bearing ores to cause the metal to be dissolved from the ore, which consists in continuously supplying a fluent mixture of comminuted ore and solvent liquor at one point, and continuously delivering the same at another point, showering the mixture through the atmosphere during its advance from the point of supply to the point of delivery; controlling the rate of such advance, and controlling the movement which causes showering independently of the rate of advance.

6. The method of treatment of precious-metal-bearing ores to cause the precious metal to be dissolved from the ore, which consists in continuously forwarding a stream of mingled comminuted ore and solvent liquor, and keeping such mingled ore and liquor in a condition of shower through the air while it is thus forwarded.

7. The method of treatment of precious-metal-bearing ores to cause the metal to be dissolved from the ore, and the metal-bearing liquor which results to be separated from the residue of the ore, which consists in the following steps: first, maintaining a continuous fluent supply and a continuous advance of mingled comminuted ore and solvent liquor, between a point of supply and a point of delivery; second, permitting a free access and circulation of atmospheric air along the path of advance from the supply to the delivery point; third, mechanically dispersing such mingled ore and liquor into the circumjacent air by movement transverse to the onward movement of the ore and liquor without separating the ore from the liquor; fourth, controlling the speed of the advancing movement of the ore and liquor, and independently controlling the speed of the transverse dispersing movement; fifth, delivering the mingled ore and liquor after a period of such dispersion sufficient to permit the metal to be dissolved from the ore; sixth, receiving and carrying the mingled ore and liquor and mechanically separating the same while carrying it, and delivering the liquor to one destination and the ore or tailings to another.

8. The method of treatment of precious-metal-bearing ores to cause the precious metal to be dissolved from the ore, and the resultant metal-bearing liquor and impoverished ore or tailings to be separated from each other, which consists of the following steps: first, maintaining a substantially continuous supply-stream of comminuted ore and solvent liquor, mingled in suitable proportions to be fluent, from a point of supply to a point of delivery; second, permitting free access and circulation of atmospheric air along the path of advance from the supply to the delivery point; third, giving to the mingled ore

and liquor sufficient movement in a direction transverse to the onward movement of the stream to cause both the ore and liquor to be dispersed in the circumjacent atmospheric air, without separating the ore from the liquor; fourth, controlling the rate of onward movement of the stream and independently controlling the rate of said transverse dispersing movement; fifth, delivering the resultant stream of metal-bearing liquor and impoverished ore, and receiving the same in mingled condition and carrying it onward; sixth, sucking the liquor from the tailings during such onward movement; seventh, delivering water to the impoverished ore or tailings remaining, and subsequently sucking such wash-water therefrom; eighth, delivering such impoverished ore or tailings after the application of such suction.

9. The method of treatment of precious-metal-bearing ores to cause the metal to be dissolved from the ore and the metal-bearing liquor which results to be separated from the residue of the ore, which consists in the following steps: first, maintaining a continuous supply-stream of mingled comminuted ore and solvent liquor; second, mechanically dispersing such mingled ore and liquor into the air, in a direction transverse to the onward movement of the stream, without separating the ore from the liquor; third, receiving and carrying the mingled ore and liquor after a period of such dispersion sufficient to permit the metal to be dissolved from the ore, and mechanically separating the same while carrying them, and delivering the liquor to one destination and the ore and tailings to another.

10. The method of treatment of precious-metal-bearing ores to cause the precious metal to be dissolved from the ore, and the resulting metal-bearing liquor and impoverished ore to be separated from each other, which consists in the following steps: first, maintaining a substantially continuous supply-stream of mingled comminuted ore and solvent liquor; second, mechanically dispersing such mingled ore and liquor into the air, in a direction transverse to the onward movement of the stream, without separating the ore from the liquor; third, delivering the resultant stream of mingled metal-bearing liquor and impoverished ore and receiving the same in mingled condition and carrying it onward; fourth, sucking the liquor from the tailings; fifth, delivering water to the impoverished tailings remaining, and subsequently sucking such wash-water therefrom; sixth, delivering such impoverished ore or tailings after the application of such suction.

In testimony whereof we have hereunto set our names, at Chicago, Illinois, in the presence of two witnesses, this 26th day of May, A. D. 1900.

GUSTAVUS A. DUNCAN.
FREDERICK H. BEACH.

In presence of—
ADNA H. BOWEN, Jr.,
EDGAR L. CONAUT.