(No Model.) 2 Sheets—Sheet 1.

S. B. LADD.

APPARATUS FOR LEACHING ORES.

No. 567,144. Patented Sept. 8, 1896.

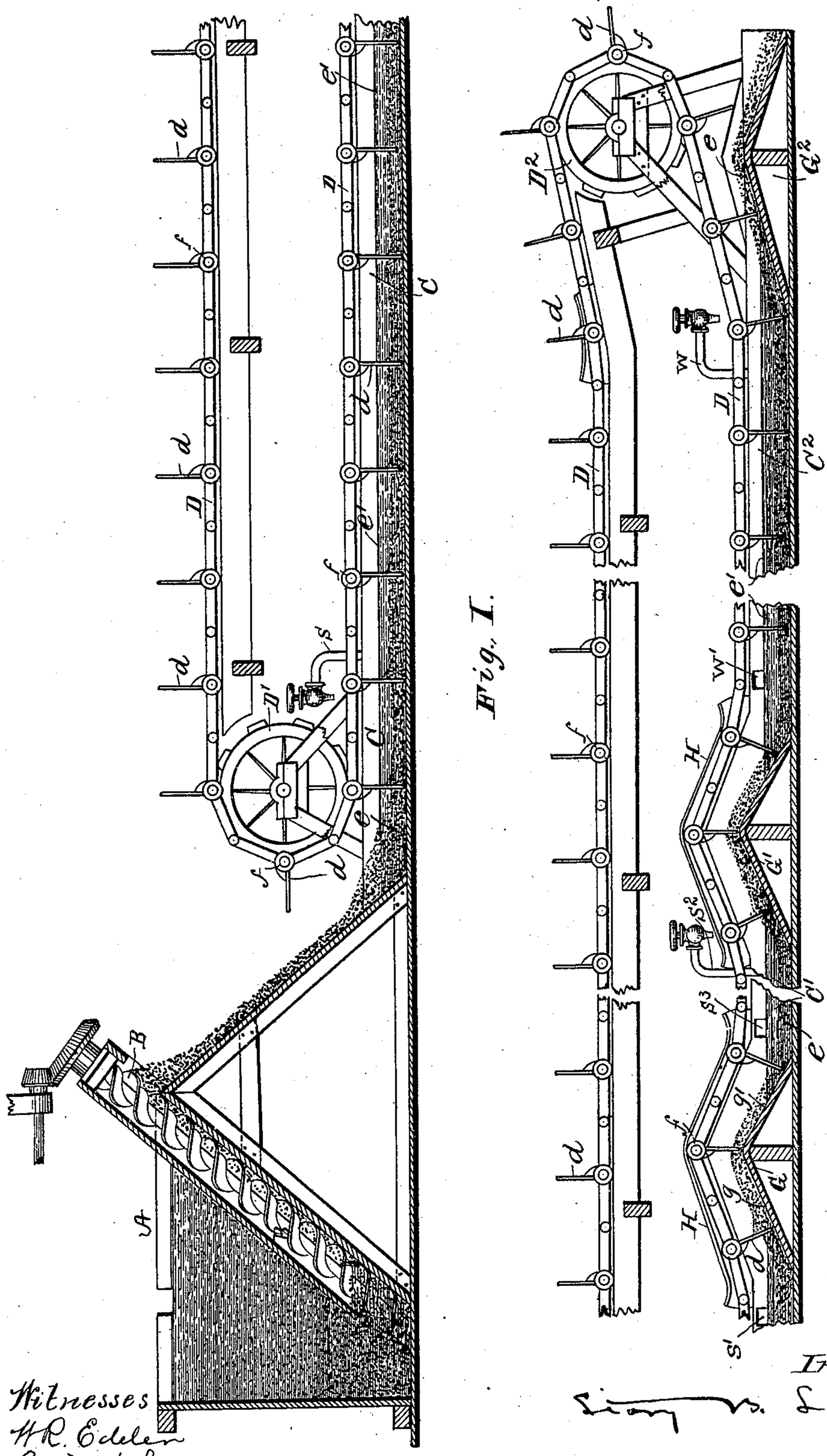

Fig. I.

Witnesses
H. R. Edelen
Geo. M. Whitney

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(No Model.) 2 Sheets—Sheet 2.

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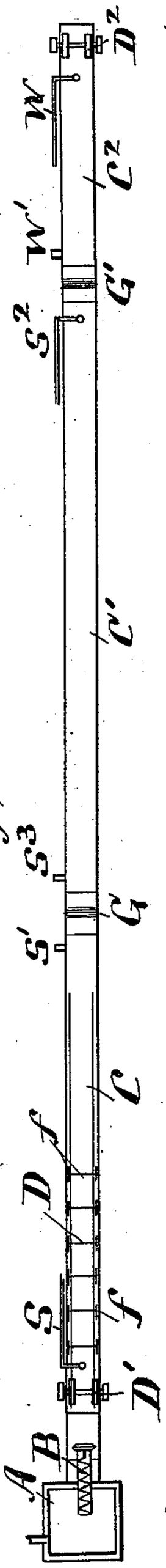

Fig. 2.

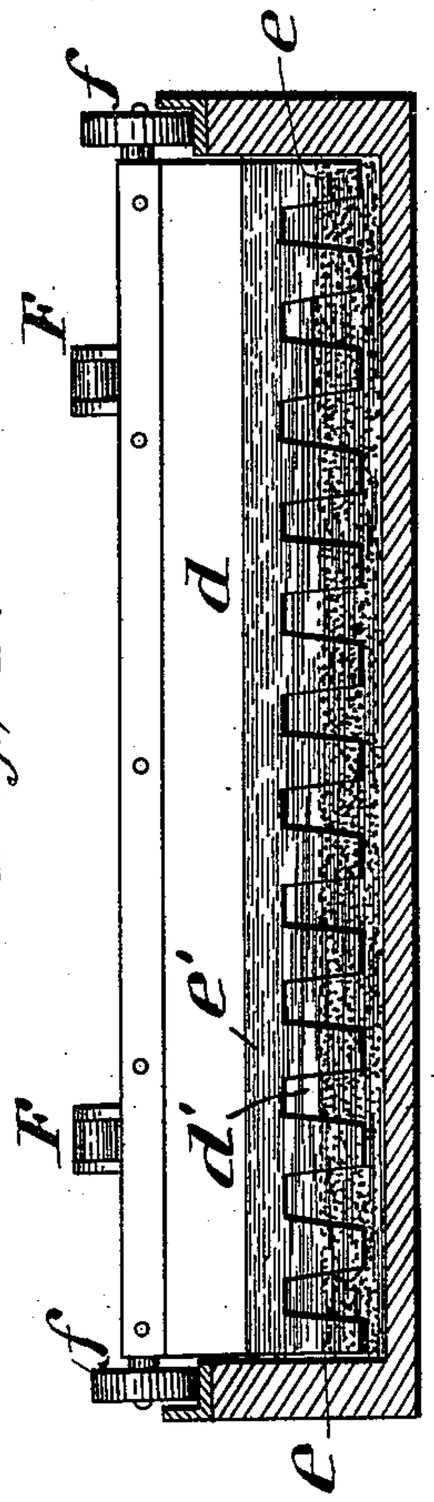

Fig. 3.

Witnesses
Geo. M. Whitney
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UNITED STATES PATENT OFFICE.

STORY B. LADD, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR OF ONE-HALF TO GEORGE B. CHITTENDEN, OF SAME PLACE.

APPARATUS FOR LEACHING ORES.

SPECIFICATION forming part of Letters Patent No. 567,144, dated September 8, 1896.

Application filed February 21, 1896. Serial No. 580,191. (No model.)

To all whom it may concern:

Be it known that I, STORY B. LADD, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Apparatus for the Leaching of Ores; 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, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

The object of the present invention is to provide an economical and practical apparatus for the lixiviation of ores, and particularly applicable to cases where a large mass of material has to undergo treatment—as, for example, in the lixiviation of low-grade gold ores by the cyanid process—and where the expense of handling material becomes an important factor with respect to the commercial working of the process. The invention applies, generically, to the lixiviation of comminuted or pulverized material of any character, but it is especially designed for the lixiviation of ores by the cyanid process and will be described with respect thereto. In the treatment of ore-pulp or slimes by the cyanid and other like processes a large amount of material, often of a low grade, has to be subjected to the action of an aqueous solution of a cyanid or other solvent, or to the successive action of a series of solutions. The common course of procedure in working the cyanid process on a large scale is to run the ore-pulp into large vats and then to cause the proper solutions for leaching out the precious metals to percolate therethrough; for example, first an alkaline solution, when the ore is acid, then a strong solution, then a weaker solution, and finally water to wash the pulp. The vat is then emptied and refilled with fresh ore-pulp; also, the solvent process is sometimes worked by agitating the pulp and leaching solution in pans or vessels. Both systems require considerable labor and are intermittent.

Another object of the present invention is to provide means to make the extraction process continuous, so that the ore-pulp shall progressively and continuously be associated with the solutions or the washings which may be necessary for thoroughly exhausting the values from the ore. This I accomplish by constructing a leaching-tank in the form of a long trough, which may be divided by one or more fixed or removable bridges into so many trough-sections as are required for the several solutions or washings when one leaching is not sufficient; or by providing a series of tanks or troughs operatively arranged with respect to each other, employing in connection therewith a conveyer for the ore-pulp adapted to continuously feed the pulp with a steady movement through the several solutions in an uninterrupted flow through the apparatus to the point of discharge without any intermediate stoppage or handling of the same whereby the lixiviation of the ore is affected.

For the purpose of rendering the operation continuous provision is made for a constant drawing off of the charged solution or solutions from the leaching-troughs and an inflow of fresh solution thereto. In the case of the first cyanid solution the inflow is preferably at the ore-entrance end of the trough or trough-section and the current is with the ore, thus catching the fine float gold carried by the fresh pulp; but in the subsequent troughs or trough-sections, and also in the first, if preferred, the inflow of the solution (or washing-water) is preferably made at the ore-exit end and the outflow of the solution is at the opposite end where fresh ore or pulp is entering the trough or trough-section. Thus, in this latter case, the flow of the solution is opposite to that of the ore. The fresh cyanid solution first acts upon pulp which is largely leached out, and as the solution becomes more and more charged with the gold or precious metals it meets pulp that is progressively richer in the metals, and the conditions are therefore favorable for effecting a complete extraction of the precious metals by the solvent. As a preferred form of conveyer, slowly-moving blades transverse to the trough or tank are used. These blades extend across the tank with just enough room at the sides for clearance, and they reach from above the surface of the solution down to and into the ore-pulp on the bottom of the tank with openings or notches in or along the

lower part of the blades for the underflow of the solution. These blades divide the trough or tank into a number of communicating divisions and form what may be called "traveling partitions," moving slowly through the trough from end to end thereof. The lower edges of these blades are preferably fashioned with rake-teeth, and they open up and rake along the layer of ore-pulp on the bottom of the tank and effect a slow and progressive movement of the mass with a constant plowing therethrough and exposure of fresh portions thereof to the action of the solution, while the solution in the tank as the series of blades move forward has to flow back through the notches or openings in the bottom of the traveling blades from each of these divisions formed by the blades, respectively, into the adjacent rear division, and thus there is secured a constant and steady underflow of the solution in close proximity to the agitated pulp. This flow of the solution is in addition to and distinct from the flow due to the constant addition of fresh solvent at one end of the trough and the drawing off of the charged solution at the other end thereof; but it will be seen that the underflow thus effected prevents a mere surface flow of the solution from one end of the trough to the other. On the contrary, as the flow from the respective divisions of the trough is from the bottom and under each traveling partition or blade the overflow or discharge from the trough at the end is necessarily of the charged portion of the solution. It will be seen that this method of leaching ores places the ore and the solvent under perfect control, which is a very great advantage with respect to the economical leaching of ores. There is an agitation and constant shifting of the pulp in the solution which very much accelerates the action of the solvent and shortens the time required therefor, and the speed of the conveyer can be regulated so that the pulp will not remain in the tank or tanks any longer than is necessary and yet long enough for the extraction of all value therefrom. On the other hand, the flow of the solvent through a tank can be gaged so that it will issue from the tank fully charged or charged to the degree most profitable under all the conditions of the case.

The invention will be fully described, and the novel feature thereof, both of a generic and a specific character, set out in the claims.

In the accompanying drawings, Figure 1 is a sectional longitudinal view of an apparatus embodying the present invention. Fig. 2 is a plan view on a reduced scale. Fig. 3 is a detail cross-section of the trough, showing a chain conveyer therein.

A indicates a settling-tank for the ore-pulp or slimes, from the bottom of which tank the pulp may be elevated by a conveyer B and fed into the head of the leaching-trough or the first section thereof, C. It is immaterial how the ore-pulp or other material to be lixiviated is fed to the leaching-trough, whether by automatic feeders or otherwise, though preferably some device that will give a regular and uniform supply of material to the head of the trough is employed, in order that the flow of the same through the trough may be uniform. In the present case the apparatus is shown as adapted for the treatment of an ore that is not acid, there being used two cyanid solutions of different strengths, and a final washing calling for the treatment of the ore in three trough-sections. The three trough-sections—for the strong cyanid solution, the weak cyanid solution, and the washing—are indicated, respectively, by C, C′, and C^2. If the ore requires the action first of an alkaline solution, it will be understood that the first section of the trough is to be supplied with an alkaline solution, and following it the necessary trough-sections for the succeeding steps. On the other hand, if the ore treatment requires but a single lixiviating bath and a washing, then there will need to be but two troughs or trough-sections, and the washing operation may be very brief or omitted entirely when not essential to the working of the material.

D is an endless-chain conveyer traversing the entire length of the trough C C′ C^2 and passing around the drums D′ D^2. This conveyer is driven by power applied to the drum D^2 and the motion is very slow, the travel of the conveyer being gaged with respect to the length of the trough and the time required for the pulp to remain in the solutions. A cenveyer is preferably employed which parts and breaks up the pulp and stirs it and prevents it from packing, as well as moves it forward, in order that the action of the solvent on the pulp may be thorough and effective, and to this end conveyer-blades *d* with a rake edge are employed, the notches or spaces *d′* of the rake edge extending up into the blade above the normal level of the pulp mass *e* on the bottom of the trough, but preferably not up to the surface of the leaching solution *e′*. The raking-blades should be set so that the teeth of one blade will register with the open spaces of the preceding blade. The action of these raking-blades on the pulp is to open up and disintegrate it, so that the solvent will have access to all parts of the mass, and at the same time to feed the pulp mass slowly forward. Moreover, if the pulp accumulates at any point in the trough and heaps up above the teeth of the blades, the impervious upper portion of the blade sweeps the pulp along and levels it off. The movement of the blades through the leaching solution, said blades extending across the trough from side to side, causes currents of the solution through the rake-teeth openings in close proximity to the agitated pulp, thereby materially assisting the leaching action of the solvent on the pulp.

F F, Fig. 3, are the endless chains of the conveyer, and *f f* supporting-rollers for the

conveyer-blades running on the sides of the trough.

Between the adjacent trough-sections there are bridges G G′, over which the pulp travels out of one trough and into the next. Thus at the end of the first trough-section C, the floor of the trough rises on a gentle incline *g* high enough to clear the surface of the leaching solution, and also to allow a short drainage slope above the same, and then it descends on an incline *g′* into the next trough-section C′. The conveyer, by proper guideways H for the same, follows the slopes of the bridge and causes the pulp to travel up out of one trough and over into the next without any interruption in its progress. This forward movement of the pulp is, however, very slow and gradual. The operation of the bridge G′ is the same, and likewise that of the final slope G^2 at the end of the trough, except that here the pulp finally leaves the trough and may be discharged into a dump-car or disposed of by conveyers or otherwise. In Fig. 1 portions of the trough are indicated as broken away on account of the great length of the same. A pipe S delivers the strong cyanid solution into the head of the trough-section C, and at the tail end of the same there is an overflow S′ for the charged solution. In the case of the trough-section C′, as before indicated, there is preferably a supply-pipe S^2 for the fresh cyanid solution at the tail end of the section and an overflow S^3 near the head of the same for the solution charged with the precious metals. In the case of the washing-section C^2, W is the waste-supply pipe, and W′ the discharge therefrom.

As the leaching operation is continuous, and does not require attention when the operation is once properly adjusted with respect to the speed of the conveyer and the flow of the leaching solutions, the trough may be closed in, if desired, to prevent the escape of the noxious hydrocyanic-acid gas or the decomposition of the leaching solution by atmospheric causes.

The foregoing is given as an embodiment of the invention in its preferred form, but it will be understood that the details can be changed without departing from the invention in its generic aspects, as, for example, it will be seen that the specific conveyer herein described, though in itself possessing important features and preferred on account of the control it gives over the flow of the solution, may be modified and some other type of conveyer used without departing from the invention with respect to its other features.

What I claim as my invention is—

1. The combination, in a leaching apparatus, of two or more troughs or trough-sections, with a conveyer adapted to feed the pulp in a continuous flow successively through the same, each of said troughs having an independent fluid-supply pipe for the inflow of a solution independent of and different from that of the others, and a discharge for the charged solution from each of the troughs.

2. The combination with a leaching-trough having parallel sides and means for maintaining a solution at the desired level therein, of a substantially horizontal series of blades suspended within and extending nearly across the trough and so arranged that each blade in the solution will extend from the surface of the solution in the trough nearly to the bottom of the layer of solution, and means for effecting a longitudinal movement between the blades and the trough, whereby there is secured a progressive feed of ore-pulp through the trough, and a scouring action of the solution on the ore-pulp due to the underflow of the solution beneath the several blades, as set forth.

3. In a leaching apparatus, a trough divided by one or more bridges into sections, each section having an independent fluid-supply pipe and adapted to hold a solvent or fluid independent of and different from that of the other trough-sections, together with a pulp-conveyer adapted to feed the pulp through the several sections of the trough and over the intervening bridges thereof in a continuous flow.

4. In a leaching apparatus, a series of troughs or trough-sections, each having an independent supply-pipe for a solvent or fluid different from that of the others, in combination with a common pulp-conveyer adapted to agitate the pulp in the several troughs or trough-sections and feed the same in a continuous flow out of and into the several troughs or trough-sections and successively through the same.

5. In a leaching apparatus, a trough divided by one or more bridges into a series of trough-sections with independent fluid-supply pipes for the several sections, in combination with an endless-chain conveyer having blades traveling in said trough and adapted to agitate the pulp therein and feed the same in a continuous flow through the several sections of the trough and over the intervening bridges.

6. In a leaching apparatus, a trough divided by one or more bridges having inclined approaches into a series of trough-sections, in combination with an endless-chain conveyer having blades traveling in said trough, and adapted to agitate the pulp therein and feed the same in a continuous flow through the several sections of the trough and over the intervening bridges.

7. In a leaching apparatus, a trough divided by one or more bridges having inclined approaches into a series of trough-sections, in combination with an endless conveyer having rake-blades traveling in said trough through the several sections of the same and over the intervening bridges.

8. The combination with a leaching-trough having an end discharge for the solution, and means for maintaining the solution in the

trough at a normal level, of an endless conveyer adapted to move the pulp along the bottom of the trough, said conveyer having rake-edged blades with the upper portion of the blades impervious and adapted to extend above the normal level of the surface of a leaching solution in the trough.

9. The combination with a leaching-trough having parallel sides and means for maintaining a solution at the desired level therein, of a substantially horizontal series of blades suspended within and extending nearly across the trough, said blades having a series of openings or notches along the bottom of each blade, with the blades so arranged that each blade in the solution will extend from the surface of the solution in the trough nearly to the bottom of the layer of solution, and means for effecting a longitudinal movement between the blades and the trough, whereby there is secured a progressive feed of ore-pulp through the trough, and a scouring action of the solution on the ore-pulp due to the underflow of the solution beneath the blades, as set forth.

10. The combination with a leaching-trough formed of a series of sections each adapted to hold an independent body of liquid, of the conveyer and the agitating-blades having passage-ways for the underflow of the liquid and adapted to feed the pulp from one section to another, throughout the trough, as set forth.

11. In a leaching apparatus, a trough having one or more bridges dividing it into a series of sections, said bridges having an inclined approach adapted to serve as a drainage-floor for the pulp, combined with an endless conveyer having notched blades adapted to agitate the pulp and feed the same through the sections in one direction, and over the bridge or bridges, and leave an opening through the notches above the pulp-bed for the underflow of fluid in the opposite direction, as set forth.

12. The combination in a leaching apparatus, of a settling-tank, a conveyer for sedimentary matter from the bottom of said tank to the head of a leaching-trough, said trough having an endless conveyer extending the length of the same and adapted to feed pulp therethrough in a steady flow, bridges dividing the trough into a series of sections, supply-pipes for leaching solution leading into one or more of the first sections of the trough at one end thereof with an overflow-discharge at the opposite end of each of the same, and a water-pipe leading to the last section of the trough with an overflow-discharge from the same opposite to the point of entrance.

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

STORY B. LADD.

Witnesses:
S. G. HOPKINS,
GEO. M. WHITNEY.