(No model.)

H. FRASCH.

MINING GOLD OR LIKE METAL.

No. 565,342. Patented Aug. 4, 1896.

Fig. I.

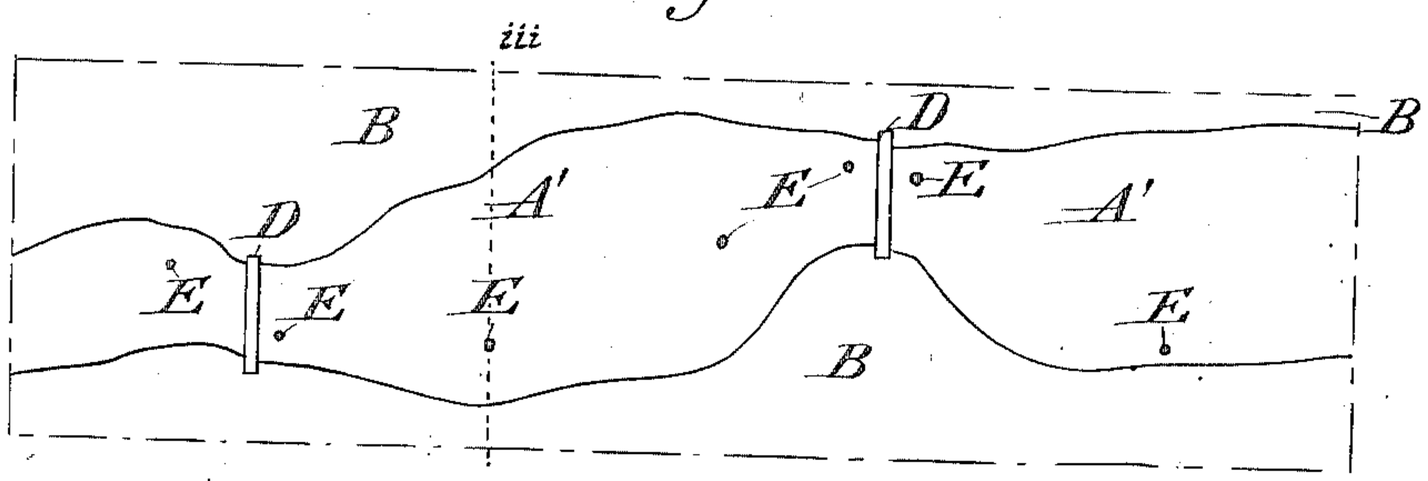


Fig. II.

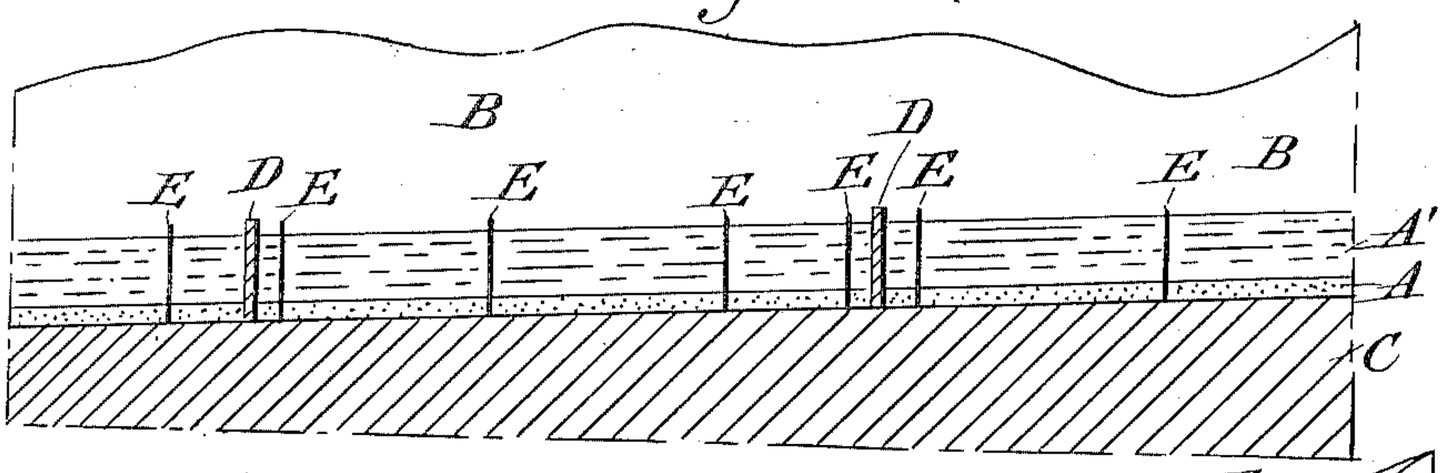


Fig. III.

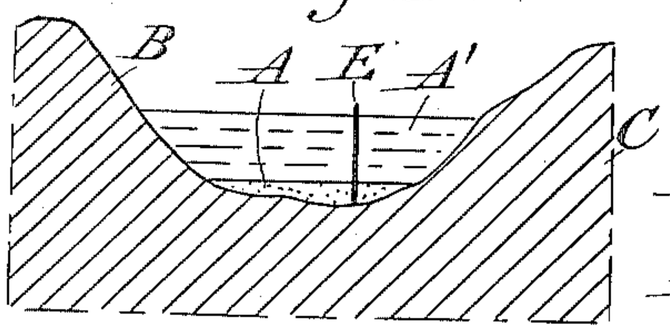


Fig. IV.

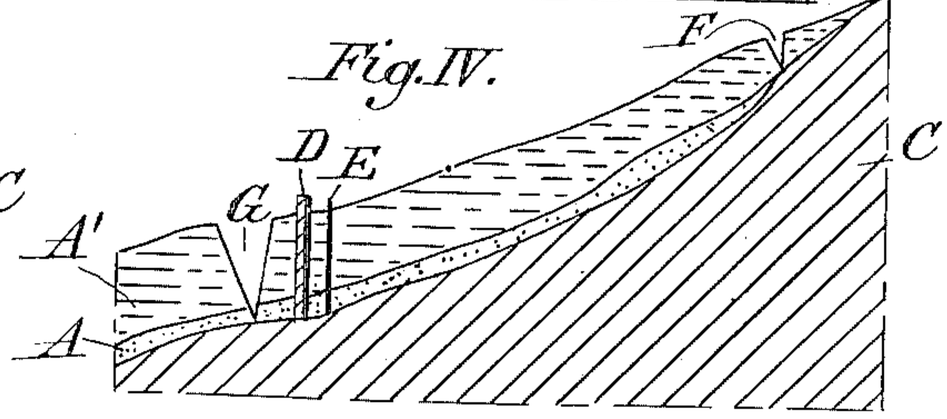


Fig. V.

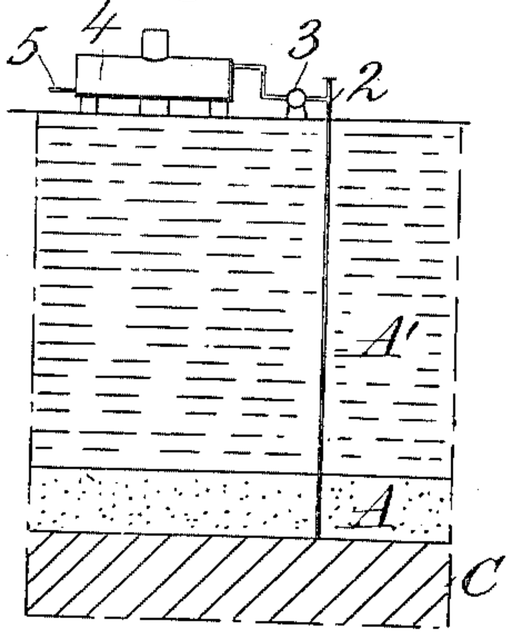


Fig. VI.

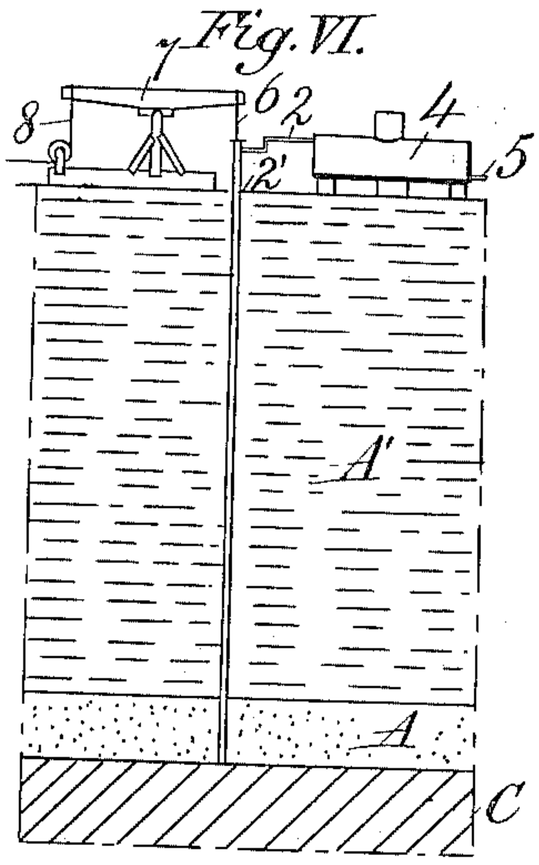


Fig. VII.

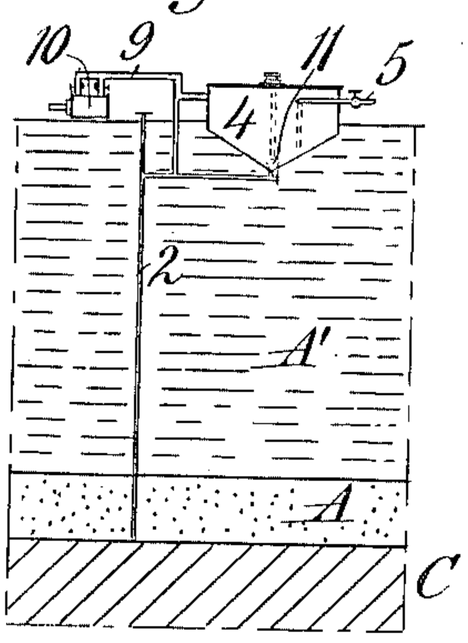
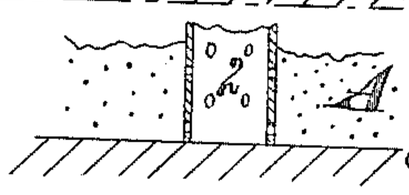


Fig. VIII.



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his attorney

UNITED STATES PATENT OFFICE.

HERMAN FRASCH, OF CLEVELAND, OHIO.

MINING GOLD OR LIKE METAL.

SPECIFICATION forming part of Letters Patent No. 565,342, dated August 4, 1896.

Application filed August 17, 1895. Serial No. 559,672. (No model.)

To all whom it may concern:

Be it known that I, HERMAN FRASCH, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Mining Gold or Like Metal; and I do declare the following to be a full, clear, and exact description of the invention.

This invention relates more particularly to the recovery of gold from placer deposits which either contain the gold in too small quantity for working by the methods heretofore known or used, or which from lack of water or peculiarity of location are not workable, at least profitably, by said prior methods. It may, however, be applied to the recovery of gold from other porous or permeable deposits and to the recovery from such deposits of analogous metal, (silver or platinum, for example,) and it is generally to be understood that each of the improvements constituting the said invention is intended to be secured for all the uses to which it may be applicable.

In accordance with said invention a reagent, which converts the naturally insoluble gold or analogous metal into a compound or compounds soluble in water, is introduced into the porous or permeable auriferous or analogously metalliferous earth, which is generally sand or gravel, as it lies in its natural bed in the ground. The aqueous solution of gold or the like, formed by the aid of such reagent, is removed by any known or suitable means for conveying liquids, such as pumping or the like, including drainage, if the situation admit of it, and the gold or like metal is recovered from the solution by known or suitable means for recovering metal from solution, such as chemical precipitation, electrical deposition, or the like. Where the earth contains other like metal as well as gold, these may be mined together by using a reagent which converts both into soluble compounds, or they can be mined separately by using in succession reagents of which each renders one of the metals soluble.

In the introduction of the reagent which renders the gold or like metal soluble hydrostatic columns, pumps, or other pressure-applying means may be used to force the reagent into the earth, or reliance may be had, when the earth is sufficiently permeable, upon gravity alone. Practically the use of pressure is important and is specially claimed.

The reagent employed may be any known or suitable substance or combination of substances for forming soluble compounds with gold or like metal, such as chlorin and bromine for gold, the alkaline hyposulfites for silver, and potassium cyanid for gold or silver, or both. Chlorin may be advantageously used for platinum. This is often present with gold and can be mined with it by means of chlorin. These are given as illustrations. Other reagents may be used. In using a combination of substances they may be used in admixture or in succession. An example of the successive use of substances would be the formation of silver chlorid by the introduction of chlorin and the making of this silver chlorid soluble in water by means of sodium hyposulfite.

It is most advantageous to use the reagent in aqueous solution, such solution being introduced into the auriferous or argentiferous or platiniferous earth in its natural bed in the ground and allowed to remain for a suitable time in contact therewith in percolating or while standing. The more or less strong solution of gold (or silver or platinum, or two or more of them) is then withdrawn.

The gold and like metals are, as a general thing, distributed unequally through placer deposits, the working of which is more particularly the object of the present invention. The gold, for example, in such deposits is, as a rule, mainly or almost wholly in the lower part near the bed-rock. The reagent may be allowed to find its way to the metal through overlying or intermediate masses of earth, which are but slightly or not at all auriferous or argentiferous or platiniferous; but it is an improvement to drive a well, shaft, ditch, or tunnel to or near the auriferous or argentiferous or platiniferous portion of the mass and to introduce the reagent more directly thereto by means of such well, shaft, ditch, or tunnel. Practically wells or shafts would be sunk or driven (at least in most

cases) down to the bed of the rock, so that the pit of the well or shaft is in the metalliferous earth.

Sometimes it may be desired to mine the metal from auriferous or like earth, which is so flooded with water as to interfere with the penetration or operation of the reagent. In such cases it may be possible to drain off the excess of water; but if this is not practicable, or it be preferred not to do so, a chemical solution of a suitably high specific gravity may be introduced under the water-carrying earth and be made to displace the water, so that the reagent may enter and act upon the gold or like metal. A proper specific gravity of the chemical solution may be obtained (at least in some cases) by the use of a sufficient quantity of reagent; but where this is too expensive or for any reason is not desirable it may be secured by additions of other substances, the most convenient substance being common salt, (sodium chlorid.)

As already indicated, the reagent may act upon the gold or like metal in percolating through the ground or while standing therein. To collect the metallic solution formed in percolation, intercepting receptacles are provided at a suitable depth having openings or outlets for giving access thereto. These receptacles may be simply the pits at the bottom of wells sunk into the mine, or they may be formed by open or covered ditches, or they may be formed in whole or in part by artificial walls, (vertical or horizontal,) or they may be formed in other like ways. To provide for the reagent standing in contact with the gold or like metal, walls may be built in the mine, so as by themselves or in connection with the natural rock to form chambers or basins inclosing the auriferous or argentiferous or platiniferous earth, access for removal of the solution of gold or like metal being given by shafts or other openings. These could serve also to introduce the chemical solution, which might, however, be allowed to percolate into the basin. In some cases artificial basin-forming walls may not be necessary, the reagent when introduced into the ground standing sufficiently in consequence of the nature or natural surroundings of the auriferous or like earth. In such case (as also in the case of an artificially-formed basin) the same pipe, well, shaft, or tunnel may serve to introduce the reagent which renders soluble the gold or like metal and to remove the solution of gold or like metal. The reagent can be applied to the same earth and the metallic solution removed therefrom repeatedly, as often, in fact, as a yield is obtained.

The mine to be treated in accordance with this invention is generally a deposit in an excavation in solid rock, (such as the bed of an ancient river,) and the most advantageous treatment (itself a special improvement) is to build one or more walls at intervals across the excavation or valley (they extending from the bed-rock upward to the surface or to any desired distance above or below the same) and to sink or drive a number of wells or shafts at intervals in the parcels of ground above such walls.

As already stated, it is an advantage and a special improvement to force the reagent into the earth. It is also an advantage to exhaust the solution of gold or like metal from the earth by the aid of a vacuum or diminution of pressure in the earth around the well-pit below the level of such solution.

In order to enable those skilled in the art better to understand and carry out the invention, the following particular examples are given by way of illustration of certain modes of practicing the invention, reference being had to the accompanying drawings, which form part of this specification, and in which—

Figures 1 and 2 are diagrams, respectively in plan and longitudinal section, of a mine in an ancient river-bed provided with artificial basin-forming walls and with wells or shafts whose pits constitute intercepting receptacles. Fig. 3 is a diagram of the same mine in cross-section on line *i i i* of Fig. 1. Fig. 4 is a diagram in vertical section of a hillside mine; and Figs. 5, 6, and 7 are diagrams of wells provided with pumping machinery which may be used for introducing or forcing the reagent into the mine or for removing or exhausting and removing the solution of gold or like metal or for both purposes. Fig. 8 is a diagram showing the lower end of a reagent-introducing or reagent-removing pipe on a larger scale than that of the other figures and in section.

Let it be assumed that the mine consists of auriferous sand and gravel A and overlying earth A′, which contains little or no gold, deposited in the bed of an ancient river between the banks B, and that such deposit averages twenty feet in depth and two hundred feet in width, the dip of the bed-rock C being fifty feet to the mile. These figures substantially represent an actual case. The diagrams, it will be understood, are not intended to preserve the proportion to one another of the different dimensions. It will, of course, also be understood that the dimensions and other circumstances and their relations to one another are variable in reality. At intervals of about half a mile or at greater or less intervals trenches may be dug across the valley down to the bed-rock. These trenches are filled with cement concrete, forming solid impervious walls D with about half a mile (or more or less, as the case may be) of deposit between adjacent walls. These parcels of ground would, of course, be the width of the valley across. In them, at, say, about one hundred feet or at greater or less distances apart, wells E may be driven down to the bed-rock and provided with suitable pipes or casings or pipes and casings.

In Fig. 5 the well is shown provided with a pipe 2, which fits closely the bore of the well, so that a vacuum can be maintained in the well-pit, the surrounding earth forming a packing. The pipe is shown as resting on the bed-rock and is provided with perforations near its lower end. Preferably the pipe 2 is of iron, coated internally and externally with lead, although it may be of wood or lead, or any material of suitable strength able to resist or protected against corrosion by the reagent. Near its upper end the pipe 2 is connected through a non-corrodible pump 3 with a lead-lined or other non-corrodible tank 4, which latter is provided with a non-corrodible pipe-line 5. The pump 3 removes the metallic solution from the well and delivers it into the tank 4, to be thence discharged by the pipe 5. The tank 4 might also serve to receive the chemical reagent and the pump 3 to withdraw it therefrom through a suitable connection with the bottom of the tank and force it through the pipe 2 into the metalliferous earth, A or the reagent may be introduced from any suitable source through the pipe 2 independent of the pump, or part may be run in directly through the pipe 2 and part be forced down by the pump 3.

In Fig. 6 the well is provided, like an oil-well, with a casing 2′ to inclose the pipe 2, and an underground pump (not represented) whose sucker-rod 6 is shown connected with one end of a walking-beam 7, the opposite end being provided with a chain or rope 8, that leads to an engine (not shown) for reciprocating it and the sucker-rod. The casing is perforated near the bottom. The pump raises the metallic solution and delivers it through the pipe 2 into the tank 4, from which it may be discharged by the pipe 5. For introducing the reagent the pump with its pipe and packer could be removed and a pipe and packer inserted for introducing the reagent.

In Fig. 7 the tank 4 has its bottom and top both connected with the pipe 2, and a branched pipe 9, with a valve in each branch, leads to both the induction and discharge sides of an air-pump 10, so that air can be forced into the tank 4 or be exhausted therefrom, as the operator may determine. A stopper 11 for closing the bottom opening when desired is indicated in dotted lines. By filling the tank 4 (through the pipe 5 or otherwise) and then compressing air into it by the pump 10 the reagent may be forced down the pipe 2, the stopper 11 being raised and the pipe 5 closed and the pipe 9 being in communication with the compression side of the pump 10. By shutting the stopper 11 and putting the pipe 9 in communication with induction side of the air-pump a vacuum can be made in the tank 4 and the metallic solution made to rise through the pipe 2 and flow into the tank 4. By opening the pipe 5 (the stopper 11 being shut) and causing the pump 10 to force air into tank 4 its contents may be discharged through the pipe 5.

The wells of Figs. 1, 2, and 3 may each be equipped like the wells of Figs. 5, 6, or 7, or in any other suitable way. The arrangements of Figs. 5 and 7 are intended for shallow wells, as they raise the solution of gold or like metal by vacuum; but the arrangement of Fig. 6 could be used with wells of any depth. A force-pump could also be used at the bottom of shallow wells. Other forms of pumping or lifting apparatus could be used instead of piston-pumps. When the wells are only twenty feet deep, they may be easily dug by hand. With drive-pipes or hydraulic wash-pipes almost any depth can be reached.

Assuming that gold is to be recovered, the reagent may be chlorin. This can be conveniently prepared in solution by dissolving chlorid of lime (bleaching-powder) in water and adding enough sulfuric acid to liberate the chlorin. The use of about four pounds of the chlorid of lime to a ton of water is recommended. The solution can be used at once, or be first allowed to settle. It is introduced into the auriferous earth through one or more of the wells, and may be introduced in sufficient quantity to soak the auriferous earth in the entire basin formed by a wall D. To do this, the height of the wall D (on the basis of a dip of fifty feet to the mile and half a mile between walls) would have to be twenty-five feet plus the depth of the auriferous deposit at the upper end of the basin. If the walls were only a quarter of a mile apart, their height might be twelve and one-half feet less with the same dip. It is not necessary, however, to fill the whole basin. The solution may be introduced at one or more of the wells and be allowed or forced to percolate to others, from which it could be pumped out. A continuous flow might, in fact, thus be maintained. If the overlying earth A′ is sufficiently impervious, the solution might be made to flow out of a well by pressure of the solution in the stratum A. The solution might simply be forced into the sand or gravel about a well, left there for a suitable time, and then pumped out through the same shaft and even the same pipe, the operation being repeated as often as desired until the yield ceases.

It is generally recommended to introduce the solution at the highest well and remove it at the lowest, or at one of the intermediate ones if it be sufficiently charged with gold.

The solution may remain in contact with the gold-carrying deposits for hours, days, weeks, months, or even years. Weak solutions may therefore be used, and the extraction can be continued until practical exhaustion of the gold. Any depth can be worked. As placer deposits do not ordinarily contain sulfids, nor other substances on which the chlorin would waste itself, loss from this cause would usually not have to be taken into account. In some cases where organic matter exists a solution of cyanid of potassium can be used more advantageously. It

can be handled with iron pumps and iron tanks. Solutions of two-tenths of one per cent. (or even one-tenth) will answer. In using chlorin for gold, if there be silver in the deposit, the chlorid of silver formed thereby could be recovered by means of hyposulfite solution. If there be platinum, it would be recovered with the gold by the chlorin.

When a sufficiently-rapid percolation is obtained thereby, the solution may simply be run into the wells; but when desired it can be forced by pressure in the wells to penetrate the surrounding earth.

The hillside mine in Fig. 4 is provided at an elevated point with a reagent-introducing opening F in the auriferous or like earth A and overlying deposit A′ in the form of a ditch and at a lower point with a cement wall D from the bed-rock C to and above the top of the ground at that point. In the ground above the wall D and in proximity thereto is a well E and below it a ditch G, which extends to bed-rock C. On introducing the reagent in aqueous solution into the ditch F by pumps, buckets, conduits or other like means, said solution flows down the hillside, percolating through the auriferous or like earth A, converting the gold or like metal therein into a compound soluble in water and dissolving the same. The wall D intercepts the metallic solution so formed, which can be removed through the well E by the appliances of Figs. 5, 6, and 7, or by other like means. In some cases gravity might force it to rise through the well-pipe; also, it might be drained off through an opening at or near the bottom of the wall D into the ditch G, from which it might be lifted out by pumps or buckets or other liquid-lifting appliances; also, the solution might be carried (if the situation permit) into a storage or treating vat at a lower level by drainage directly from the receptacle or basin above the wall D or from the ditch G. If desired, the solution can be removed as fast as it percolates into the receptacle formed by the wall D, or it can be allowed to collect therein and to stand in contact with the gold or like metal before it is removed. Further, the wall D and well E might be dispensed with, and the solution be intercepted by the ditch G, to be removed by pumping, drainage, or otherwise. Of course also the wall D might be used without the ditch and without the well E, if other suitable outlet be provided.

After the gold solution has been obtained, the gold is recovered therefrom as may be preferred. Electrical deposition is considered the most advantageous mode, the chlorin solution being regenerated while the gold is deposited. It is unnecessary to go into the details of an electric deposition, as those skilled in such matters will understand how to apply it. So, also, if chemical precipitation be preferred for the recovery those skilled in the art will understand how to apply it without further instructions. The regenerated solution of chlorin could be introduced again into the auriferous earth.

If an analogous metal, like silver or platinum, is to be mined instead of or along with gold, the preceding description will suffice for skilled persons to accomplish the formation in the ground of a solution of such metal as well as the removal thereof from the ground and the recovery of the metal from the solution, electrical deposition and chemical precipitation being available, as when gold is mined alone.

I claim as my invention or discovery—

1. The process of mining gold, or analogous metal such as silver or platinum, by introducing into the auriferous or argentiferous or platiniferous earth in its natural bed in the ground a reagent which converts such metal into a compound soluble in water, and removing the aqueous solution of gold or like metal formed by the aid of such reagent; substantially as described.

2. The process of mining gold, or analogous metal such as silver or platinum, by introducing into the auriferous or argentiferous or platiniferous earth in its natural bed in the ground a reagent which converts such metal into a compound soluble in water, removing the aqueous solution of gold or like metal formed by the aid of such reagent, and recovering the metal therefrom; substantially as described.

3. The process of mining gold or analogous metal such as silver or platinum, by forcing under pressure into the auriferous or argentiferous or platiniferous earth in its natural bed in the ground a reagent which converts said metal into a compound soluble in water, and removing the aqueous solution of gold or like metal formed by the aid of such reagent; substantially as described.

4. The process of mining gold, or analogous metal such as silver or platinum, by introducing into the auriferous or argentiferous or platiniferous earth in its natural bed in the ground an aqueous solution of a reagent which converts such metal into a compound soluble in water, and removing the aqueous solution of gold or like metal formed by the aid of such reagent; substantially as described.

5. The process of mining gold, or analogous metal such as silver or platinum, by driving a well, shaft or opening in the ground through overlying or intermediate masses to, into, or through the auriferous or argentiferous or platiniferous earth or its vicinity, introducing into such earth through such well, shaft or opening, a reagent which converts such metal into a compound soluble in water, and removing the aqueous solution of gold or like metal formed by the aid of such reagent; substantially as described.

6. The process of mining gold, or analogous metal such as silver or platinum, by introduc-

ing into the auriferous or argentiferous or platiniferous earth in its natural bed in the ground an aqueous solution of a reagent which converts such metal into a compound soluble in water, such solution being of a high specific gravity and so introduced as to displace water which the said earth may carry, and removing the aqueous solution of gold or like metal formed by the aid of such reagent; substantially as described.

7. The process of mining gold, or analogous metal such as silver or platinum, by introducing into the auriferous or argentiferous or platiniferous earth in its natural bed in the ground a reagent which converts such metal into a compound soluble in water, causing such reagent in solution to percolate through such earth from its point of introduction to one or more intercepting receptacles, and removing the aqueous solution of gold or like metal formed by the aid of such reagent; substantially as described.

8. The process of mining gold, or analogous metal such as silver or platinum, by driving a well, shaft or opening in the ground through overlying or intermediate masses to, into, or through the auriferous or argentiferous or platiniferous earth or its vicinity, introducing into such earth through such well, shaft or opening, a reagent which converts such metal into a compound soluble in water, causing such reagent in solution to percolate through such earth, and removing the solution of gold or like metal from one or more intercepting receptacles through other wells, shafts or openings; substantially as described.

9. The process of mining gold, or analogous metal such as silver or platinum, by inclosing the auriferous or argentiferous or platiniferous earth in its natural bed in the ground in one or more artificially-formed basins, introducing into such basin a reagent which converts such metal into a compound soluble in water, and removing the aqueous solution of gold or like metal formed by the aid of such reagent; substantially as described.

10. The process of mining gold, or analogous metal such as silver or platinum by inclosing the auriferous or argentiferous or platiniferous earth in its natural bed in the ground in one or more artificially-formed basins, driving one or more wells, shafts or openings into the earth in such basins or the vicinity thereof, introducing into the basins a reagent which converts such metal into a compound soluble in water, and removing the aqueous solution of gold or like metal formed by the aid of such reagent; substantially as described.

11. The process of mining gold or platinum, by introducing a solution of chlorin into the auriferous or platiniferous earth in its natural bed in the ground, and removing the chlorid-of-gold or platinum solution formed thereby; substantially as described.

12. The process of mining gold or platinum, by introducing a solution of chlorin into the auriferous or platiniferous earth in its natural bed in the ground, removing the chlorid-of-gold or platinum solution formed thereby, and recovering the gold or platinum by electrical deposit; substantially as described.

13. The process of mining gold or platinum, by introducing a solution of chlorin into the auriferous or platiniferous earth in its natural bed in the ground, removing the chlorid-of-gold or platinum solution formed thereby, recovering the gold or platinum and regenerating the chlorin solution by electrical deposit, and introducing such regenerated solution into the ground for acting again upon the gold or platinum to effect its removal in solution; substantially as described.

14. A mine of gold, or analogous metal such as silver or platinum, composed of one or more wells, shafts or openings in the ground to, into, or through the permeable auriferous or argentiferous or platiniferous earth or the vicinity thereof, and provided with means, such as pumping machinery or the like, for introducing or forcing a fluid reagent into the said earth, and for removing or exhausting and removing the gold or silver or platinum solution; substantially as described.

15. A mine of gold, or analogous metal such as silver or platinum, composed of a basin with an artificially-formed wall or walls inclosing auriferous or argentiferous or platiniferous earth in its natural bed in the ground, with one or more wells, shafts or openings into said basin, and provided with means, such as pumping machinery or the like, for introducing or forcing a fluid reagent into the earth in said basin and for removing or exhausting and removing the gold or silver or platinum solution from the said basin; substantially as described.

16. A mine of gold, or analogous metal such as silver or platinum, composed of one or more reagent-introducing wells, shafts or openings in the ground on one side of the permeable auriferous or argentiferous or platiniferous earth and on the other side thereof one or more intercepting receptacles having openings to give access to such receptacles, said mine being further provided with means for introducing the chemical reagent and removing the solution of gold or analogous metal; substantially as described.

17. A mine of gold, or analogous metal such as silver or platinum composed of a deposit of auriferous or like earth in a natural excavation like a river-bed, and provided with one or more basin-forming walls across the excavation or valley and also with one or more wells or shafts in the parcels of ground above such walls; substantially as described.

18. The process of mining gold, or analogous metal such as silver or platinum, by introducing into a natural body of permeable auriferous or argentiferous or platiniferous

earth in its natural bed in the ground a reagent which converts such metal into a compound soluble in water, so that the said earth is permeated by said reagent percolating through or standing in the said earth and the particles of gold distributed through said earth are thus exposed to said reagent, removing the compound thus formed in dilute aqueous solution, and recovering the metal therefrom; substantially as described.

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

HERMAN FRASCH.

Witnesses:
F. W. LOTHMAN,
N. J. WORLEY.