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E. D. KENDALL.

PROCESS OF RECOVERING METALS.

(Application filed July 9, 1900.)

(No Model.)

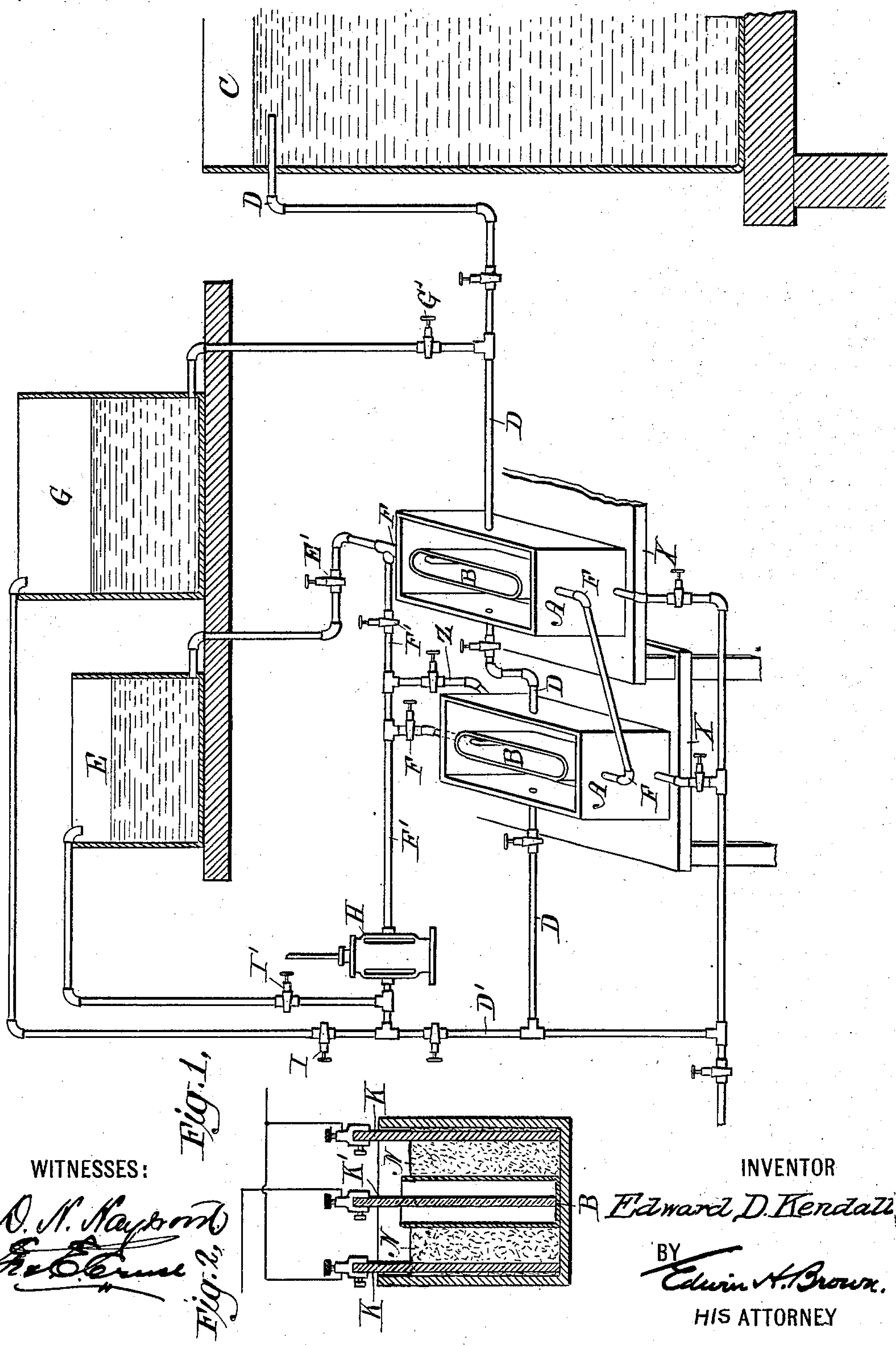

Fig. 1.

Fig. 2.

WITNESSES:

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PROCESS OF RECOVERING METALS.

SPECIFICATION forming part of Letters Patent No. 698,292, dated April 22, 1902.

Application filed July 9, 1900. Serial No. 22,912. (No specimens.)

To all whom it may concern:

Be it known that I, EDWARD D. KENDALL, a citizen of the United States, residing in the borough of Brooklyn, city and State of New York, have invented a new and useful Process of Separating and Recovering Metals from Solutions Containing the Same, of which the following is a specification.

My invention relates to a process for separating and recovering metals from solutions containing the same.

I will describe a process embodying my invention and then point out the novel features in claims.

My process consists in flowing through and over a mass of carbon presenting a large area of surface a dilute solution of potassium cyanid containing gold or silver, or both metals, derived from the lixiviation of ores and at the same time subjecting the solution to the action of an electric current. The electric current is preferably of comparatively high voltage—say fifteen volts. The mass of carbon, which, preferably, is in the form of granules or fragments, serves as the cathode, while a carbon or carbons immersed in a solution of caustic alkali or a solution of cyanid contained in a porous cell or cells may serve as the anode. The liquid passing off the carbon mass flows to the sump. After a time—that is, after a sufficient quantity of metallic gold or silver, or both, has been deposited on and in the fragmental mass of carbon by electrolysis—the flow of weak solution is stopped and the electric current shut off. All liquid is then drawn out of the electrolytic tank and porous cell, after which both tank and porous cell are to be filled with a comparatively strong solution of potassium cyanid or other suitable cyanid containing, say, one-half pound of cyanid to the gallon. The carbon anode may be removed from the porous cell and a copper plate, preferably silvered and rubbed with plumbago, substituted therefor to serve as cathode. Preferably the strong solution will be made to flow from the carbon mass into the porous cell in order to bring the freshly-dissolved metal into contact with the new cathode. It is also desirable that a circulation of the strong solution be maintained from the source of supply of strong solution through the electrolytic tank and porous cell and back again to the source of supply. At the same time the strong solution and carbon mass, with deposited gold or silver, or both, and copper plate, are subjected to the action of an electric current. In this instance the copper plate serves as the cathode and the carbon mass, with its deposited metal, as the anode, and this arrangement of electrodes, together with the solution, causes the gold or silver, or both, to be dissolved from the carbon mass and deposited on the copper plate, from where it may be removed as desired. After the last operation the copper plate is removed and the carbon substituted and the poles changed in order that fresh dilute solution containing the gold or silver, or both, may be subjected to the electrolytic action.

The purpose of preferably employing caustic alkali in the porous cell is to take up that part of the cyanogen set free from the weak solution of cyanid by electrolysis which finds its way into the porous cell and which would otherwise be lost.

In the accompanying drawings I have illustrated a form of apparatus in which my process may be carried out.

In the said drawings, Figure 1 is a view, partly in section and perspective, of an apparatus in which my process may be performed. Fig. 2 is a detail cross-sectional view of a portion of the plant or apparatus.

Similar letters of reference designate corresponding parts in both of the figures.

A A are electrolytic tanks, which may be made in any desired form and of any suitable material.

B B are porous cells, which may be made of any required form and of any suitable material. Each of these porous cells is provided with openings, to serve as inlet and outlet for liquid, and with connecting-pipes F F F F. One of the pipes in each porous cell should have a termination near the bottom of the cell to insure the flowing of liquid throughout the interior of the porous cell and not merely across it and as a means of emptying the cell of liquid in the way herein to be described. The top of each porous cell B is lower than the top of the containing-tank A, (or if as high there should be an opening in its side near the top,) so that liquid flowing into A during a part of the process to be described may, when so required, pour over into B from A.

C is a settling-tank through which flows the dilute solution which is to be treated for the recovery of contained gold and silver. This settling-tank serves as a reservoir of this solution, which it may receive directly from a leaching-vat in the lixiviation of ores.

D D D D are pipes conveying solution from the settling-tank C into and out of the electrolytic tanks A A and for delivering this solution after its electrolytic treatment into the sump. The flow of liquid through these pipes is to be regulated by suitable valves, or, preferably, iron cocks properly placed. The arrangement of these must of course depend on the number of electrolytic tanks and their positions with reference to other parts of the plant. In the drawing Fig. 1 two of the said tanks are shown arranged in series, one being in lower position than the other. A greater number of such tanks may be used, arranged in step order, all of the solution from settling-tank C flowing through each and all of the electrolytic tanks, or these tanks may be used separately, only a portion of the said solution flowing through each.

E is a receptacle for a chemical solution which is to be supplied to the porous cells B B through the pipes E' E'.

G is a receptacle for a chemical solution which is to be supplied to the electrolytic tanks A A through the pipes G' and D D.

H is a pump adapted and arranged to draw liquid from the porous cells B B or from the tanks A A through the pipes F F, F' F', or Z and deliver the same through the pipe D' to the sump, or through the pipe I to the receptacle G, or through the pipe I' to the receptacle E. The pipes and cocks X X are for drawing off residues from the tanks A A for the sump. At the opposite ends of the tanks A A may be arranged pipes and cocks in similar positions (one of which is indicated at Z) for drawing off certain residues; but these last-mentioned pipes and cocks, while useful in certain contingencies, are not a necessary part of the plant.

Fig. 2 is a cross-section of one of the electrolytic tanks A prepared for use, in which A'' indicates the shell or walls of the tank, and B the porous cell. K, K, and K' are rods or plates of hard or battery carbon. Each has a suitable connection with a copper wire or other conductor of electric current. The space between the outer sides and ends of the porous cell B and the inner surfaces of A', within which are the carbon rods or plates K K, are packed with granulated or fragmental hard carbon N N.

In carrying out my process I proceed as follows: The carbon rods or plates K K are connected with a direct-current electric generator or other source of pure current, so as to constitute, with the contiguous mass of fragmental carbon, the cathodic electrode, and the carbon rods or plates (indicated at K'') are so connected as to form the corresponding anode. Then a continuous supply of the dilute solution—say of potassium cyanide—containing gold or silver, or both metals, from the settling-tank C is conducted by the pipes D D D D through the electrolytic tanks A A and through the contained masses of carbon N N, and finally to the sump. The porous cells B B are filled with a solution of caustic alkali drawn from the receptacle E. A solution of cyanid may be substituted for this, but not with the same advantage, because the alkali serves to utilize part of the cyanogen otherwise set free and lost. Under these circumstances with an electric current of sufficient voltage—say fifteen volts—and amperage proportionate to the capacity of the plant the gold and silver are rapidly separated from the flowing solution and deposited on and throughout the masses of fragmental carbon and a portion on the carbon rods or plates K K. When a considerable quantity of metallic gold and silver has accumulated on and within the cathodic electrode, the flowing of solution from the settling-tank C is stopped, (or the solution is conducted through a duplicate and alternate series of electrolytic tanks,) and the residue of the same remaining in the electrolytic tanks A A is drawn off by means of the cocks and pipes X X and allowed to flow to the sump. The solution in the porous cells B B is drawn off through the pipes F F and F' F'' by the pump H and conducted by the pipe I'' to the receptacle E. The porous cells and the tanks A A being now free from liquid, prior to the next step in the process the carbon rods or plates (indicated by K' in Fig. 2) may be removed from the porous cells and plates of copper, preferably silvered and rubbed with plumbago, or plates of other suitable metal, may be substituted for the carbon. The receptacle G contains a comparatively strong solution of potassium or other suitable cyanid—say half a pound of potassium cyanid to each gallon of water—and the quantity of this solution required is somewhat more than sufficient to fill the electrolytic tanks and the porous cells which are now to be supplied with this cyanid solution by opening the cock G''. The cock I also being open, the pump H is operated occasionally or slowly, so that the solution flowing from the receptacle G into the electrolytic tanks A A and over the tops of the porous cells B B into the same shall be drawn out of these cells through the pipes F F and F' F' and forced through the pipe I back to the receptacle G, thus establishing continuous or intermittent circulation of the liquid. At the same time a reversed electric current is sent through each electrolytic tank and its porous cell, the carbon rods or plate K K, and the contiguous mass of fragmental carbon N N now constituting the anodic electrode and the carbon rods or plates K'' (or the copper plates which may have been substituted therefor) being the cathode. This electric current is so adjusted with reference to voltage and amperage that the gold and silver on and in the carbon N N and on the touching rods or plates K K shall be taken up by the solution from G and redeposited in coherent form on the cathode in the porous cells. When the metal or metals shall have been so redissolved and redeposited, the cathodes are to be removed from the porous cells and the accumulated electrolytic deposit stripped or otherwise separated from them. The cock G′ being closed, the stronger solution of cyanid is to be pumped out of the tanks A A and the porous cells through the pipes Z, F″, and I or through the pipes X, D″, and I′ into the receptacle G. With the carbon rods or plates K′ replaced in the porous cells dilute solution for the electrolytic tanks is to be drawn from the settling-tank C and the porous cells filled with solution from the receptacle E, and the process above described is to be repeated.

What I claim as my invention is—

1. The process of separating and recovering metals from solutions containing them, which consists in flowing over a mass of fragmental carbon which serves as a cathode, a dilute solution of potassium cyanid containing metals in solution, and at the same time subjecting the dilute solution to the action of an electric current having sufficient amperage and electromotive force of at least five volts, the anode being carbon immersed in a solution of caustic alkali which is separated from the cathode solution by a porous diaphragm.

2. The process of separating and recovering metals from dilute solutions of cyanid containing them which consists in flowing said solutions over and through a fragmental mass of carbon presenting a large surface area, and which carbon mass serves as cathode, a plate or plates of carbon serving as anode, subjecting said flowing solution to the action of an electric current having an electromotive force of five volts or more, next stopping the flow of dilute solution and flowing over and through the fragmental carbon mass a stronger solution of potassium cyanid and at the same time subjecting the deposited metal to the action of a reversed electric current, not exceeding electromotive force of five volts using the carbon mass as anode and a plate of metal for the cathode.

3. The process of separating and recovering metals from dilute solutions containing them which consists in flowing said solutions over and through a fragmental mass of carbon presenting a large surface area, and which carbon mass serves as a cathode, a plate of carbon immersed in solution of potassium or sodium hydroxid serving as anode, which solution of potassium or sodium hydroxid is separated from the cathode solution by a porous diaphragm, whereby cyanogen set free by an electric current is reconverted to alkali cyanid, subjecting said flowing solution to the action of the electric current having an electromotive force of five volts' strength or more next stopping the flow of dilute solution and flowing over and through the fragmental carbon mass a stronger solution of potassium cyanid and then subjecting the deposited metal to the action of a reversed electric current not exceeding an electromotive force of five volts, using the carbon mass as anode and a plate of metal for the cathode.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDWARD D. KENDALL.

Witnesses:
GEO. E. CRUSE,
R. H. E. STARR.