

works in Berlin lost weight when standing idle in the cyanide liquor without any electric current passing through the bath. This fact, backed by the statements of chemical authorities that gold is soluble in cyanide, first induced him to try the use of cyanide solution to extract gold from ores. In the same year he built a small plant to make experiments on concentrates produced at Siebenburgen. The gold was precipitated from the solution both by electrolysis and with zinc filings. It was found, however, that the zinc method gave good results with strong solutions only, while the electric precipitation was equally effective with either strong or weak solutions, and its efficiency was not lessened by the presence of caustic soda. Dr. Siemens therefore decided to use electrolysis only. Early in the year 1888 he commenced operations on a larger scale, and engineers were sent out to several different countries. Two went to Hungary, another to America, and the author to Siberia. The results obtained were generally satisfactory, although, as might be expected, they varied considerably owing to the different conditions existing in the respective places. Nothing was done in this country at that time, as the patent question was not then settled. Except to mention the fact that Mr. Siemens was the applicant for and holder of the first patent in the Transvaal for the extraction of gold by means of cyanide, it is not necessary to discuss this matter, as such questions are beyond the scope of a technical paper. It would be superfluous to explain the elementary principles of electrolysis to the members of this Society, but it is necessary to point out some of the reasons why such a large number of electrolytic processes have not succeeded commercially, the output from them having been larger in profanity than in gold. As you are aware, the electric current decomposes a solution of a metallic salt, the metal being deposited on the negative pole, while the metalloid is liberated at the positive pole of the electrolytic cell. In a fixed time a given electric current will deposit a certain quantity of metal, which quantity varies for different metals in direct proportion to their electro-chemical equivalents. This law holds good only for solutions strong in metal, but with very dilute solutions, as in use in the cyanide process, the current does not find sufficient of the metallic compound present at the electrodes, and consequently decomposition of water also takes place. For this reason, to make the efficiency of the precipitation as great as possible, constant diffusion of the solution is requisite. In order, therefore, to create an artificial diffusion a mechanical movement of the solution is important, and the most economical and convenient way of effecting this is to allow a slow but steady flow through the precipitation-boxes. But it is still more important to give a very large surface to the electrodes. In fact, a better result is obtained by doubling the number of plates than by increasing the current tenfold. For this reason it will be seen that mercury cathodes cannot be used with good results. In order to precipitate 100 tons of cyanide solution containing 5dwt. of gold per ton, in twenty-four hours, about 10,000 square feet of surface is required. If the bottoms of the precipitation-boxes were covered with mercury it would be necessary to have it at least a quarter of an inch deep to make up for difference of level, and thus insure that the whole surface should be covered. This requires over 200 cubic feet of mercury, weighing 80 tons. Not only the initial expense, but also the trouble in cleaning up makes the use of mercury in this way as an electrode impracticable. The vertical position in which metallic plates can be placed has the great advantage of keeping the surface of the cathodes clean, as any solid matter entering the boxes in suspension sinks to the bottom of the latter, no obstruction being offered to its downward course. Sheets of solid metal (as copper) coated with mercury have also been tried, but have been unsuccessful, because the mercury, owing to the action of the current, will penetrate the copper and form a dry amalgam, which does not adhere to the plate. To obtain a satisfactory cathode a metal must be used which will fulfil the following conditions: (1) The precipitated gold must adhere to it; (2) it must be capable of being rolled out into very thin sheets to avoid unnecessary expense; (3) it must be easy to recover the gold from it; (4) it must not be more electropositive than the anode, in order to prevent return currents being generated when the depositing current is stopped. The most suitable metal for the purpose is lead, which is therefore used in the Siemens' process, and which meets all the requirements of the case. Not less important is the question of anodes. By the action of the current a metalloid is liberated at the positive electrode, and the latter, when a metal, begins to oxidize. Carbon could be used as an anode, but it will not withstand the action of the current, and soon crumbles into a powder, which decomposes cyanide. This finely-divided carbon is in suspension, and cannot be removed from the solution by filtration. Zinc used as an anode forms a white precipitate of ferro-cyanide of zinc by the reaction of zinc oxide upon ferro-cyanide formed during the leaching. Similarly iron anodes form Prussian blue by the reaction of oxide of iron and ferro-cyanide. In consequence of this reaction the amount of ferro-cyanide in the cyanide solution does not increase. From the Prussian blue the cyanide can be recovered by dissolving it in caustic soda, then evaporating the solution, and finally smelting with potassium-carbonate. This last process has been carried out only on a small scale, about 50lb. at a time, but a nice clean cyanide-potassium was obtained. In the treatment of tailings the regeneration of cyanide is not of great importance, but with concentrates, which decompose the solution with formation of ferro-cyanide, it will effect a considerable economy. In order to precipitate the gold from cyanide solutions only a very weak current is required—that is to say, a density of about 0.6amp. per square foot. With cathodes about 1½in. apart, four volts is sufficient to produce this current strength. The advantages gained by using a weak current are: (1.) The gold is deposited hard on the plates. (2.) The iron anodes are preserved for a long time, as their waste is in proportion to their current strength. In a plant treating 3,000 tons per month, 1,080lb. of iron are destroyed in that period. (3.) Little power is required. 746 Watts equal 1-horse power. A 3,000 tons plant requires 2,400 Watts, equal theoretically to 3¼-horse power, and actually requiring about 5 indicated horse-power. The most important feature of electrical precipitation is that it operates on the solution quite independently of the amount of cyanide or caustic soda that it contains. Precipitation by means of a chemical reaction is invariably more complete with a solution strong in cyanide than with a weak one, but with electricity is absolutely