

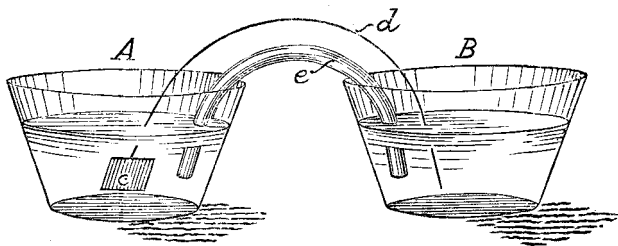
remind him that oxygen at ordinary temperatures is not an electric conductor; it is therefore physically incapable of acting the part here assigned to it.

By the way, I would remark that the use of a mercuric cyanide in the potassic-cyanide solution, feasible—nay, profitable—as it should be on theoretical grounds, is not likely to be successful, and for the reason I have stated in 1895.* The fact is, that, though the gold becomes quickly amalgamated, and there is every sign of a rapid dissolution of the gold, these are appearances only, as the deposited mercury greatly interferes with the passage of the underlying gold through it to the cyanide-solution, nor, indeed, “does it,” as I say, “entirely go before all the mercury thus deposited has also been dissolved.” The process is really retarded instead of being accelerated by this chemical amalgamation of the gold. These statements of mine have since received confirmation as to their absolute correctness by the results of certain experiments of the author of the work on metallurgy that I quoted from (Dr. Kirke Rose, D. Sc., A.R.S.M., F.C.S., &c.).

The next theory, that of Dr. Hood, claims that the cyanodizing of gold is always effected by a displacement of another metal from the cyanide used by it—that, in fact, as he goes on to say, “pure alkaline cyanides cannot dissolve gold”—meaning, of course, in the oxygenated solution. To meet this theory, I need only ask him, I think, what metal or metals are likely to be in the cyanide, or even in the auriferous mine-stuff itself, that gold could displace from a cyanide-solution. The table of mine referred to only names the metals platina, iron, lead, and mercury as being negatives to gold in cyanide-solutions; but certainly platina is out of the question, while iron would not be replaceable. There only, then, remains mercury and lead, and neither of these are present in cyanide-solutions except on very rare occasions. But, independent of this, we know that gold absolutely pure (as prepared from its pure chloride by oxalic acid) is dissolvable by the weak cyanide. Clearly, then, this theory is disproved by fact.

THE ACTUAL CHEMICAL DECOMPOSITIONS THAT OCCUR IN THE PROCESS.

Two theories have been formulated to explain how gold becomes dissolved in the cyanide process. One is that given by a joint patentee of the process, Mr. McArthur. This assumes that water is decomposed, its oxygen being used to replace the cyanogen necessary to cyanide the gold, while its hydrogen is evolved. Now, this theory is that of the minority, and is still, I believe, held by its author. My own experiments in this matter gave, as I have already stated,† results entirely against it, and I have seen no reason to alter my expressed opinion in this matter—that is, as regards the practical working of the process; but by an apparently trivial and unimportant variation in cyaniding gold we actually do get a liberation of hydrogen. For this it is only necessary to so arrange that the negative gold of the cyanide apparatus (the voltaic cell, as it really is) shall be placed in an acid solution—say, in hydrochloric, sulphuric, or acetic acid. The diagram here given explains what I mean. A is a vessel containing potassic cyanide of any strength, in which is a sheet of gold-leaf (gummed to paper). B is another vessel, containing the acid in water heavily salted to drive out the oxygen that might interfere with the result. In this vessel is a gold wire *d*, which is connected with the gold-leaf *c*. Interpolated connection is completed by the bent glass tube *e* that is full of hydrated, but almost solid, gelatine, slightly salted for conducting purposes, if necessary.



Soon after this arrangement is set up a stream of gas may be observed issuing from the gold or platina wire. This is hydrogen, and the evolution goes on continuously till all the gold-leaf is dissolved. It is necessary to have a small cathode and a large anode to be certain of success in the experiment, as cyanodizing is at the best a slow process, and even concentrated solutions of the acids and salts let in oxygen fast enough to oxidize hydrogen to a notable extent, and thus prevent its liberation being noticed. It is a singular fact that if potash, or any alkaline solution, were substituted for the acid in B, I was unable to observe any evolution of gas, yet the currents formed appear as strong as when the acid was used. It is possible, however, that potash, by its great affinity for water, so rapidly determines the oxidation of hydrogen that none is to be seen escaping.

These results, while they clearly show the unexpected fact to many that hydrogen can be liberated in a cyanide process, show just as clearly that in the process as carried on at the mines the gas is never evolved, but is, so to speak, only transferred in a liquid form to the oxygen present at the anode. The process there demands that the oxygen shall be present there and in quantity, while the alkalinity of the solutions around them favours the rapid union of this gas with oxygen before it can assume the gaseous form, or even before it can in reality become free.

It should be stated that a brisk evolution of hydrogen is afforded by cyanodizing copper, even when the anode is in an alkaline solution. This branch of the investigation requires further researches.‡

The next theory, and the popular one, to explain the chemistry of the process involves the decomposition of potassic cyanide, the cyanogen combining with the gold as before, while its potassium combines with oxygen gas as present in the solution. This view appears reasonable,

* Twenty-ninth Annual Laboratory Report, p. 44.

† Mines Report for 1895, p. 88.

‡ Regarding the gold used in this experiment, I should state that it did not contain silver, copper, or iron.