

amalgamation-process, these are generally not re-ground but treated as delivered. The finely-divided material is mixed with a solution of cyanide, say cyanide of potassium containing, on an average, 0.4 per cent. of cyanogen as the cyanide of potassium, or other alkali or alkaline earth. The ore and the solution are stirred together for about six hours or less, this being the average time required to dissolve the gold. In practice the time required is determined by experiment. When the gold is known to be dissolved the pulp is discharged into an ordinary filtering-tank, where the filtration may, if necessary, be assisted by suction, and where the ore is washed by water or by the waste cyanide solution from a previous operation. The ore after treatment with cyanide solution is unchanged to the eye, as nothing but the imperceptible proportion of gold has been removed. The gold now being in solution, the next object is to get it precipitated, and here we encounter a serious difficulty. Gold and cyanogen have such a strong mutual affinity that it is difficult to get any substance that will separate them. The gold cannot be precipitated by any ordinary method, such as the use of ferrous sulphate or oxalic acid. Even sulphuretted hydrogen and sulphide of sodium will not precipitate gold from its cyanide solution, though they precipitate silver. We noticed, however, that zinc precipitated gold very feebly, and tried this in the same way that copper is precipitated from its ordinary solutions by scrap-iron, but scrap-zinc had no effect. Then granulated zinc was tried, with a most imperfect and disappointing result. Then heating in presence of scrap and granulated zinc; but this had only the effect of forming urea, and assisting the precipitation very little. Further, we tried zinc-dust, but still there was no success. Finally we prepared some zinc in the form of sawdust, porous and with a large surface of bright metal. On allowing the cyanide of gold to trickle through a mass of the zinc, we found that it trickled out gold-free; and, better still, we found that the action became more vigorous and pronounced after the gold had been precipitated on it, doubtless as gold and zinc formed together a more powerful electro-chemical precipitant than zinc by itself. An arrangement of a porous mass of zinc like a sponge formed a chemical filter, which at once precipitated and collected the precious metal; indeed, so like an ordinary water-purifying device was this zinc filter that many non-technical visitors formed and held tenaciously to the idea that the gold was in suspension in the cyanide solution and the zinc was used merely because of its durability. Improvements in detail were made in the direction of increasing the surface and decreasing the weight of zinc till now we have it in threads, 1 lb. of which occupies about a two-gallon measure. The zinc in this form is possessed of enormous chemical activity, of which the strongest and most direct evidence is the fact that it burns in the air like thin shavings of wood. When the gold has been deposited it is necessary to separate it from the excess of the zinc present. The filiform structure of the zinc, and the exceedingly fine powder as which the gold is deposited, renders this an easy matter. The filiform mass of zinc, with gold powder adhering, is vigorously shaken in water, when the gold falls off, and the fibrous particles of zinc may be collected in a sieve. The gold settles easily, is collected and fused directly into bullion.

"Having now described the chief points in the process from the technical standpoint, let us look at the purely chemical aspect it presents. Reference has already been made to the fact that a cyanide solution acts on gold-ores in preference to the sulphides of base metals with which it may be combined or associated. This selective action is the keystone of the whole process. It is also known that sulphides of copper, zinc, and iron, artificially prepared, are readily acted on by a cyanide solution; but we found a very different state of affairs in treating ores where these or similar compounds exist prepared by the hand of Nature herself. Nature seems to render the base metallic compounds insoluble, while the gold combined with or contained in them is more easily acted on than the metal itself. This at once raises the question, How does gold exist in base refractory ores? Is it combined or free? Judging from theoretical considerations only, gold should exist almost invariably in a free state, for, if we assume that sulphides, pyrites, &c., were formed by deposition from aqueous solution, the gold would be deposited in a metallic state. This may be shown by dropping some powdered pyrites into a solution of chloride of gold, when gold will be precipitated as metal. On the other hand, let us assume that the pyritous formations carrying gold were formed by igneous agency. In this case the gold ought to be metallic too, because any sulphide of gold already existing would be decomposed by the high temperature, and, of course, sulphide of gold cannot be formed at a high temperature. It is true that sulphide of gold may combine with an alkaline sulphide and resist decomposition by heat, but such a combination, as a matter of fact, does not occur in Nature. Telluride of gold and antimonide of gold are not decomposed by heat; but they occur in small quantities, and do not affect the general argument. In spite of these theoretical considerations, however, we have strong evidence to show that gold exists in several different states of combination or molecular structure. Let me give one case in illustration: A sample of tailings from the ordinary process of stamping and amalgamation was received, and it may safely be assumed that the mercury had extracted some of the gold from the ore which produced these tailings. We treated the finely-ground tailings by alkaline solution of bromine, which extracted a considerable portion of gold, and the bromine treatment was repeated time after time till it ceased to extract gold. Then it was treated with a hot solution of ferric bromide, which yielded a further quantity of gold. This treatment was repeated time after time till it ceased to extract gold, and finally the residue of tailings was smelted, and still a further quantity of gold produced. As this ore yielded its gold in stages to form different processes—namely, amalgamation, treatment with bromine, treatment with ferric bromine, and smelting—we infer that gold existed in four different states—mechanical or chemical. Notwithstanding the complex nature of these tailings, the cyanide acted on it almost perfectly, extracting 93 per cent. of the precious metal.

"The advantages claimed for the cyanide process over smelting and chlorination are, as compared with smelting, it requires no furnaces, no coal, and no fluxes. As compared with chlorination,