

# UNITED STATES PATENT OFFICE

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## PROCESS FOR CONCENTRATING ORES

No Drawing.

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This invention consists of a means for concentrating ores or ore products, such as tailings, classifier overflow, fines, slimes, or flotation middlings, by a combination of leaching and flotation methods having particular reference to the recovery of copper values occurring in the form of sulphides or as oxides or other acid soluble compounds. Although this invention may be used advantageously when the copper values occur as sulphide or as oxide or predominately as sulphide or as oxide, it has particular advantage in the recovery of copper values from ores containing mixed sulphide and oxide copper or other acid soluble compounds thereof. The difficulties encountered in the treatment of oxides or other acid soluble compounds of copper by flotation methods and sulphides of copper by leaching methods are well understood. In treating a mixed copper ore containing both sulphides and oxides, high percentages of the oxides are lost by the flotation method and high percentages of the sulphides are lost by acid leaching.

Attempts have been made to treat such mixed ore by dissolving the acid soluble copper in the pulp, precipitating the dissolved copper in the form of metallic copper back into the pulp and subjecting the pulp then containing metallic and sulphide copper to flotation. Such proposed methods have not received commercial application for various reasons, principally because the copper was not precipitated in a form readily amenable to flotation and because of the time consumed and the extensive and expensive equipment required to separate the dissolved acid soluble copper compounds from the gangue.

We have designed our process for the purpose of overcoming the difficulties present in the other known methods. Our process consists in producing, by means of a dilute solution of a solvent in quantity and strength requisite to the process, a thick pulp of the material to be treated. The pulp should be as dense as is consistent with carrying out the process; in practice, a pulp of 80% solids has given efficient results. The quantity of acid is determined by the characteristics of the material to be treated. The pulp is passed continuously through a rotating mixing cylinder. The rotation of the mixing cylinder produces an intimate contact between the solvent and the mineral to be treated and induces the passage of the pulp through the cylinder, during which the active dissolution of the acid soluble mineral proceeds. The lining of the cylinder may be of an acid resisting material, in order to prevent corrosion of the cylinder and to avoid unnecessary consumption of acid. To bring about the dissolution of all possible acid soluble minerals, it is important that the maximum amount of contact of acid with the mineral to be treated be afforded in the mixing cylinder. This is effected by controlling the speed of the progress of the pulp through the mixing cylinder by regulating its inclination, length and rate of rotation, according to the requirements of the material to be treated. It has been found with an ore ground to six-mesh size and containing seven pounds of acid soluble copper to the ton, that a mixing period of ten minutes is sufficient. The pulp is passed continuously from the mixing cylinder into a grinding mill or series of grinding mills containing iron balls, iron rods, or other shapes or iron grinding media which will comminute the material to be treated and concurrently with comminution, act as a precipitant for the metal in solution, which it is desired to precipitate. The linings of the grinding apparatus may be of a precipitant or non-precipitant material, as preferred. In the grinding apparatus, the comminution of the material to be treated proceeds continuously and concurrently with solution of the acid soluble portions thereof, with precipitation in elemental form of the metal or metals in solution on the surface of the grinding media, and with removal of the precipitated material from the grinding media by abrasion and attrition, whereby a pulp is formed which is particularly amenable to flotation.

The pulp is fed to the grinding mill at such a rate as to accomplish most efficiently the process as above described.

The pulp containing the finely divided precipitated metal in elemental form, the clean sulphides, if any, the gangue and other orig-