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TREATMENT OF SULPHIDE ORES

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30 Claims. (Cl. 75—21)

This invention relates to metallurgy and has for an object the provision of an improved method of treating ores, concentrates and other mineral and metallurgical products containing iron sulphide. More particularly, the invention contemplates the provision of an improved process for recovering iron from iron sulphide-bearing materials. The invention further contemplates the provision of an improved method of treating ores and other iron sulphide-bearing materials for the recovery of practically all of the metals and metalloids therein in the form of marketable products. A further object of the invention is to provide an improved method for producing a metallic iron product containing one or more alloying elements such as copper and nickel.

Throughout the remainder of the specification and in the appended claims, I shall use the term "ore" to cover and include all iron sulphide-bearing ores, concentrates and other mineral and metallurgical products which are amenable to treatment by the method of the invention. Throughout the specification and claims the term "ferra" is used to describe free or uncombined ferrous oxide (FeO).

This application is a continuation in part of my application, Serial No. 505,250, filed December 29, 1930 (Patent No. 1,976,735, dated October 16, 1934).

The method of the invention may be employed advantageously for the treatment of both simple and complex ores. Thus, for example, the method of the invention may be employed advantageously for the treatment of ores consisting substantially entirely of iron sulphide, ores consisting largely or iron sulphide and earthy constituents or gangue materials, or ores containing iron sulphide and one or more sulphides or other compounds of other metals such, for example, as copper, gold, silver, zinc, lead, cadmium, selenium, arsenic, antimony, thallium, germanium, cobalt, nickel and tin together with greater or lesser amounts of earthy constituents or gangue materials such as quartz and silicates.

For the treatment of ore consisting substantially entirely of iron sulphide or consisting largely of iron sulphide together with small amounts of earthy or gangue constituents, the invention contemplates an intensive oxidizing treatment by means of which the iron and other constituents of the ore may be obtained in forms suitable for the recovery of valuable products therefrom.

For the treatment of complex ores, the invention contemplates a series of alternate oxidizing and reducing operations in the course of which the metals and metalloids in the ore are selectively isolated and recovered substantially in their entirety as valuable commercial products. The oxidizing and reducing operations may be considered as in the nature of alternate titrations with oxygen and reducing agent, preferably with such over-oxidation and over-reduction as to insure completeness in the characteristic reactions of each operation. The invention thus involves a pyrometallurgical treatment of a mixed or complex sulphide ore in which the successive oxidizing and reducing operations are selective separating or concentrating steps in each of which a practically complete stage of dissection is attained.

In carrying out a process of the invention for the treatment of complex ores, the various operations involved therein may be controlled to insure the production of metallic iron products containing desirable amounts of non-volatile elements such as copper and nickel. Thus, for example, the production of a metallic iron product containing copper may be accomplished (1) by selecting for treatment ore containing iron and copper in the desired proportions, carrying out the intensive oxidation until an iron oxide-bearing product in which the copper is present in the metallic or oxide form is produced, and subjecting the resulting product to a reducing treatment until a product in which the iron and copper are present in metallic forms is produced; or (2) by subjecting to intensive oxidation ore in which the ratio of copper to iron is greater than that desired in the final metallic iron product, subjecting the product of the oxidation treatment to a selective reduction treatment to eliminate the excess copper and form an iron oxide-bearing product which may be reduced to form a metallic iron product containing copper in the desired proportion.

Alloying elements such, for example, as copper and nickel may also be incorporated in metallic iron products formed in accordance with the method of the invention by adding the elements or suitable compounds of the elements to the charge undergoing treatment at any suitable time prior to complete conversion of the iron of the charge to metallic iron or by adding the elements or suitable compounds of the elements to the metallic iron product while molten.

The invention, in some of its various aspects, is based on the fact that substantially complete elimination of sulphur contained in a charge comprising iron sulphide can be accomplished by intensive oxidation of the charge with the pro-