UNITED STATES PATENT OFFICE.

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PROCESS OF TREATING ORES PREPARATORY TO SMELTING.

1,378,411. Specification of Letters Patent. Patented May 17, 1921.

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To all whom it may concern:

Be it known that I, JULIUS W. HEGELER, a citizen of the United States, and resident of Danville, in the county of Vermilion and State of Illinois, have invented a new and useful Improvement in Processes of Treating Ores Preparatory to Smelting, of which the following is a specification.

This invention relates to the art of zinc ore smelting and relates particularly to a preliminary treatment of the ore preparatory to the actual smelting operation or process.

As is well known to persons familiar with the art, the method of smelting zinc ore used most extensively at the present time, consists in mixing the ore—which has been previously calcined, when necessary,—with anthracite coal, coke or so-called "dead" coal, or any desired and suitable mixture or combination thereof, which serve as a reducing agent in the subsequent stages or steps of the process, and charging said mixture into the retorts of a smelting furnace, said retorts being heated to such a temperature as may be necessary to reduce the zinc to metallic form and to distil the same.

It is also recognized that for the efficient and economic smelting of the charge, it is necessary that the ore and reducing agent shall be crushed or reduced to granular form of desired fineness and thoroughly mixed so that the ore and reducing agent shall be in intimate physical association and contact with each other, while at the same time providing sufficient porosity or openness in the mass to permit free access of heated gases generated in the subsequent smelting operation to all parts thereof and free escape of the zinc fumes produced by distillation of the metallic zinc liberated as a result of the reaction between the zinc ore and carbon contained in the charge.

In their very nature, these conditions are conflicting, as the finer the ingredients are crushed, the better as regards their intimate association and contact, whereas the coarser the granulation, the better as regards the porosity or openness of the mass, and where the granular ingredients are charged into the retorts in a loose mass, the size of the particles must of necessity be a compromise between these extreme conditions, thereby correspondingly impairing the most efficient operation of the furnace. Another serious objection to charging the mixture into the retorts in the form of a loose mass is the tendency of the ingredients to segregate in transportation and handling between the mixer and the retorts.

Extensive tests and experiments have been made to meet the ideal conditions of intimate association and requisite porosity by crushing the ingredients to any desired degree of fineness and briqueting the mixture by means of a suitable binder. This system is objectionable from a practical standpoint because of complications which arise in its practice and also on account of its excessive cost. The object of my invention is to overcome the objectionable features inherent in the foregoing processes, and to this end, it consists in mixing properly prepared ore and coking coal or other coking material in such proportions as may be desirable, both the ore and coal having been previously reduced to granular form of any degree of fineness that will give the most desirable results, said mixture being made as homogeneous and uniform as possible. Said mixture is then coked under conditions best suited to the particular character of the coal or other coking material employed, whereby the volatile portions of the coal will be driven off, either wholly or in such part as experience shows will give the best results with different ores and coals or other coking materials in the subsequent smelting operation, the entire charge coming from the oven in the form of coke in which the ore is firmly embedded or cemented and throughout which it is thoroughly and uniformly disseminated, the ore particles being also impregnated with carbon. The coke is then crushed to any degree of fineness, which—when charged into the retorts of the smelting furnace—will most effectively promote the accessibility and diffusion of heated gases produced by the smelting operation to all parts of the charge, and the escape of metallic fumes and vapors therefrom.

As is generally well known to persons familiar with the zinc smelting art as at present practised, where the granular ore and carbon necessary for reduction are charged into the retorts in the form of a loose, non-coherent mass, there is a tendency toward segregation in transport and handling from the time the material leaves the mixer until it is charged into the retorts, and that, as segregation results, it will destroy in large measure, that intimate associa-

tion and contact of the ore and carbon necessary for the most effective reduction of the ore contained in the charge. By my improved process, segregation of the ore from the carbon is prevented and the intimate association and contact of the ore and carbon assured, due to the fact that the ore and carbon may be charged into the coking ovens directly from the mixer. When coking of the coal or other coking material occurs, the desired intimate association and contact of the particles of ore and carbon become fixed and will not be destroyed or in any way impaired or affected by subsequent handling.

I have found in practice that this intimate and fixed association and contact of the particles of ore and carbon result both in a very material acceleration of the subsequent reduction and distillation of the ore with a corresponding increase in the daily capacity and yield of the retorts, and also in the recovery of an appreciably larger percentage of the metal contained in the ore.

In the smelting of zinc ore, it is desirable to prevent the formation and segregation of molten slag, which not only tends to settle to the bottom of the retorts, corroding the same and materially reducing the life thereof, but by adhering to the sides of the retorts, renders it difficult to properly clean the same—that is to remove the residue therefrom—and through improper cleaning reduces the capacity thereof, thus correspondingly reducing the size of the charge and the output of the furnace. By my improved process, these objectionable features are effectively overcome, as it is found that, as the smelting process progresses, the non-fusible carbon particles in the charge and the ash will form a porous, spongy mass, throughout which the fusible constituents of the charge will be thoroughly disseminated and by which the particles of the charge which would otherwise form slag, with its attendant injurious effects will be held apart.

While I have herein referred only to the coking of a mixture of ore and coal in granular form, my invention contemplates the addition to the mixture of other materials or reagents desirable to be used in the final charge introduced into the furnace, thereby insuring not only an intimate and fixed association and contact of the particles of ore and carbon, but a correspondingly intimate association and contact to the other materials or reagents contained in the charge.

It is generally recognized that, in smelting zinc ore, the effective reduction of the ore and distillation of the metallic zinc is promoted by the presence in the charge of a small percentage of volatile hydrocarbons and in accordance with my invention, the presence of such hydrocarbons may be obtained by properly regulating the temperature at which coking is effected.

In addition to the foregoing advantages, I have discovered that the coking of the coal or other coking constituents of the charge may be effected in ovens of the by-products coking type and that the usual by-products distilled in the coking operation will be unaffected by the presence of the zinc ore and will be equally available for all commercial and economic purposes as are the by-products distilled from coke or other coking material in by-products coking ovens when ore is not present.

In the aggregate, the by-products driven off in the coking of coal amount to a large percentage by weight of the total quantity of coal used and, if permitted to go to waste, would very greatly increase the cost of the process, though this disadvantage would be more than offset by the advantages and economies resulting from my improved process and where, to the advantages specified, is added the value of the by-products recovered, the economic results of my improved process very greatly exceed those of any smelting process of which I have any knowledge.

For the reasons stated, my invention contemplates the coking of the coal or other coking constituents of the mixture in ovens of the by-products coking type.

The term "coking coal" as used herein is intended to include all coals of the bituminous type which have a sufficient amount of the binding or resinic constituent to form a coherent mass upon the application of heat to the point of decomposition or in the ordinary process of destructive distillation. In the intent and meaning of the term, all caking coals are considered to be coking coals. In the same manner, the term "other coking material" as used herein is intended to include pitch residues from the distillation of tar, petroleum or asphaltic material which, upon the application of the usual processes of carbonization, will result in the formation of a coherent mass of coke.

To recapitulate, among the important advantages of my improved process of treating ore preparatory to smelting as compared with any other processes of smelting of which I have any knowledge, are the following:—

1. It increases the percentage of metal recovered in the smelting operation;

2. It accelerates the smelting operation, thereby correspondingly increasing the daily capacity of the furnace;

3. It materially reduces the quantity of carbonaceous material necessary to reduce the ore;

4. It prevents separation of slag with its attendant objectionable results; and

5. The preliminary treatment of the ore in accordance with my improved process may be effected under conditions permitting of the recovery of the by-products, thereby correspondingly increasing the practical and commercial value of the process.

What I claim is:—

1. In the art of zinc ore smelting, a preliminary treatment of the ore for the purpose of producing a fixed mixture of zinc ore and carbon, which consists in intimately associating and commingling zinc ore and coking coal or other coking material, and in then subjecting said mixture to a coking process, substantially as described.

2. In the art of zinc ore smelting, a preliminary treatment of the ore for the purpose of producing a fixed mixture of zinc ore and carbon, which consists in intimately associating and commingling zinc ore and coking coal or other coking material and in then subjecting said mixture to a coking process under conditions which permit of the recovery of the by-product constituents of the coal, substantially as described.

3. In the art of zinc ore smelting, a preliminary treatment of the ore for the purpose of producing a fixed mixture of zinc ore and carbon, which consists in substantially associating and commingling zinc ore and coking coal or other coking material in granular form, and in then subjecting said mixture to a coking process, substantially as described.

4. In the art of zinc ore smelting, a preliminary treatment of the ore for the purpose of producing a fixed mixture of zinc ore and carbon, which consists in intimately associating and commingling zinc ore and coking coal or other coking material, fixing said mixture by subjecting it to a coking process, and in then reducing the coked mass to pieces of desired size for smelting, substantially as described.

5. In the art of zinc ore smelting, a preliminary treatment of the ore for the purpose of producing a fixed mixture of zinc ore and carbon, which consists in intimately associating and commingling zinc ore and coking coal or other coking material in granular form, subjecting said mixture to a coking process, and in then reducing the coked mass to pieces of desired size for smelting, substantially as described.

6. In the art of zinc ore smelting, a preliminary treatment of the ore for the purpose of producing a fixed mixture of zinc ore and carbon, which consists in intimately associating and commingling zinc ore and coking coal or other coking material, and in then subjecting said mixture to a coking process under conditions which will effect distillation of a part only of the volatile hydrocarbons, substantially as described.

7. In the art of zinc ore smelting, a preliminary treatment of the ore which consists in intimately associating and commingling zinc ore and coking coal or other coking material, subjecting said mixture to a coking process, and granulating the coked mass to form pieces of desired size for distillation in zinc retorts, substantially as described.

8. As a new material for zinc smelting, a granular charge material comprising carbon and zinc oxid, each granule comprising a plurality of particles of zinc oxid spaced and united by hard carbon of the nature of coke cementing the same into a firm aggregate, substantially as described.

In testimony that I claim the foregoing as my invention, I affix my signature this 5th day of April, 1920.

JULIUS W. HEGELER.