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METHOD FOR SMELTING SULFIDE BEARING RAW MATERIALS

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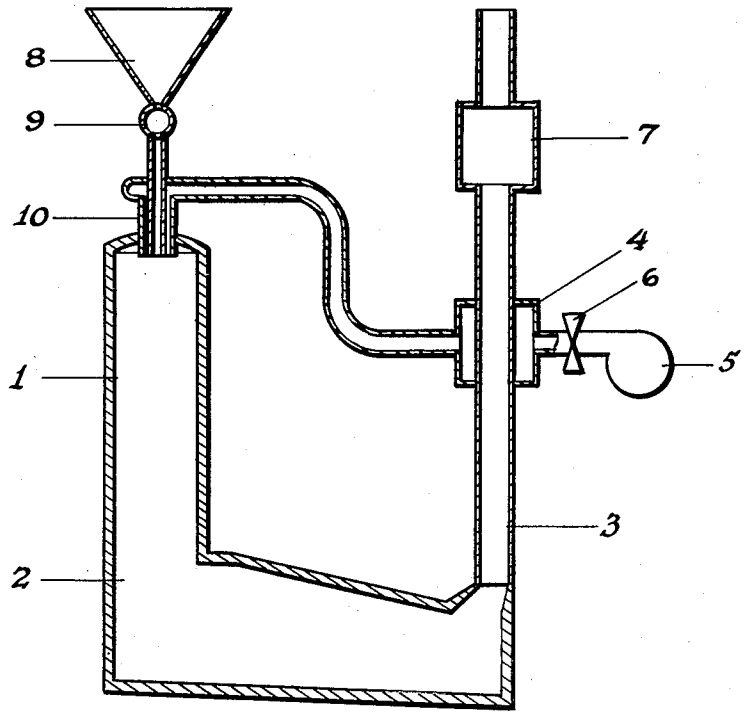


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## METHOD FOR SMELTING SULFIDE BEARING RAW MATERIALS

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This invention relates to a method of smelting sulfide bearing raw materials as e. g. copper concentrate.

The prior known methods utilized in connection with recovering copper are based in the main on the use of furnaces, either blast, reverberatory or electric. The smelting method now most generally in use is the reverberatory according to which e. g. a concentrate roasted to a specific sulfur content is fed into the furnace and the requisite temperature attained by means of burning e. g. pulverized coal, fuel oil or natural gases. Electric energy substitutes fuel in the electric furnace method. From the metallurgical point of view both of these methods are fit for use, but both involve considerable amounts of extraneous heat, reverberatory smelting approximately 10–20 per cent. coal per ton concentrate and electric smelting about 500 kwh. per ton charge.

Theoretically the so-called pyritic smelting can be conducted without use of extraneous fuel, i. e. the combustion heat of sulfur and iron contained in the sulfide raw material is utilized. Pyritic smelting takes place in the blast furnace and due to the construction and operation of the furnace rich lump ore must be used as raw material. Pyritic smelting is characterized by the fact that in the furnace combustion air and raw material always travel in counter current to each other so that the combustion heat of so-called pyritic sulfur is not utilized effectively because it does not burn until at the mouth of the blast furnace. Practice has proved that pyritic smelting is difficult to attend to, and that the charge requires an additional amount of about 1–3 per cent of coke.

H. Freeman (e. g. Swedish Patent No. 77,454) has patented a method according to which iron sulfide is roasted, by means of oxidizing gas, to sulfur dioxide and iron oxide. Characteristic of this method is the fact, that the pulverized sulfide ore fed to the combustion chamber on coming down, runs into the rising oxidant air current, which retards the fall of the particles. In the upper part of the combustion chamber, where nitrogen and sulfur dioxide are the chief constituents of the gas, the concentrate is pre-heated in the main to reaction temperature. Combustion proper of said sulfur occurs in the intermediate or primary combustion zone. In the bottom or secondary combustion zone the rising air runs into the glowing particles and there burns the major portion of iron and the residue sulfur. The formation of black iron oxide takes place in this zone. Below the secondary combustion zone

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the air then cools the iron oxide which is recovered as a heavy, black powder. In this method attention is drawn to the fact that the partial pressure of oxygen is at its minimum there where the concentrate is fed to the furnace and at its maximum when the reaction practically is completed already and the iron oxide has reached the solid phase.

T. R. Haglund (Swedish Patent No. 96,977) has patented a method for roasting or roasting and smelting sulfide bearing raw material and differing from the aforestated invention inter alia in that oxygen gas or oxygen-enriched gas "containing appreciably more oxygen than that held in air" is utilized as an oxidizing gas.

This invention relates to a method for smelting pulverized sulfide bearing raw materials according to which the raw material itself acts as heat imparting matter. As compared to other prior known methods this invention has for its object a marked improvement in methods for smelting pulverized sulfide raw materials because smelting can be effected very economically indeed for in the smelting process there is no need to resort to the use of oxygen gas or gas enriched by oxygen. In accordance with the invention the pulverized sulfide bearing raw material is fed to the smelting chamber together with the preheated air current so that i. e. the pyritic sulfur contained in the concentrate immediately begins to dissociate and burn. Thus an immediate rise in temperature in turn effects an increase in the reaction velocity proper of the sulfide bearing raw material in respect to the oxygen contained in the air. It has been proved in practise of this invention that by conducting the raw materials in the flow direction of the pre-heated air current said raw materials are smelted very rapidly indeed because the temperature of said materials continually proceeds to rise as it travels along with the ever hotter gas current. By regulating the air to the amount desired and by pre-heating it, the process can be controlled in such a way that a specified reaction product is obtained. This is easily accomplished because the partial pressure has a maximum at the starting point of the process and diminishes as combustion proceeds while reaction velocity on the other hand increases due to the rising temperature. Practise, namely, has shown that by accurately regulating the quantities of both concentrate and air in respect to each other a result is attained corresponding to that calculated theoretically. Such theoretical calculations are well known to those skilled in the art and are shown in numerous

texts, such as for instance, "Metallurgical Problems" by Allison Butts, published by McGraw Hill Book Company, Inc., New York, 1943. In putting this invention into practise it has been found that so much heat is evolved in the reaction zone where smelting occurs that, by means of flue gases, the pre-heating of combustion air and the drying and pre-heating of the concentrate can be carried out effectively and that also radiation losses are compensated. By roasting and smelting the sulfide bearing raw materials in the flow direction of the air current pre-heated e. g. with flue gas the raw material without use of exterior fuel is obtained in a liquid state as matte and slag or as metal and slag.

The annexed drawing illustrates schematically one form of furnace in which the method of the invention may be practiced.

The dry sulfide bearing raw material such as copper concentrate and slag forming materials are driven into feed bin 8 and therefrom, by means of an accurately regulated feeding-device 9, into burner 10 and are smelted under the effect of pre-heated air in combustion chamber 1. The air and the raw material come together at the exit of the burner 10 and the smelting commences at this position. Smelting continues and the reaction velocity increases as the air and raw material move downwardly in the vertical chamber 1. The smelted raw material is converted into molten particles which form adjacent the bottom of the vertical chamber 1 and fall unto furnace hearth 2 where slag and matte or slag and metal separate. The combustion gases flow from the bottom of the vertical chamber 1 across the horizontal hearth 2 and above the smelted material collecting and separating thereon. They leave at the remote end of the hearth 2 through gas flue 3 and exit through air pre-heater 4 and concentrate drier 7. Ventilator 5 blows combustion air into the air pre-heater and the air amount is accurately regulated and measured by means of control device 6 and then flows into burner 10 where it runs into the dry and warm concentrate.

The liquid product obtained from the furnace hearth is recovered in the known manner and is handled, depending on its quality, in accordance with prior known methods. Now it might suit the purpose well, especially when matte richer than normally or e. g. raw metal is formed, to couple a reverberatory furnace or an electric furnace of the well-known construction in connection with the apparatus set forth in this invention where e. g. slag refining can be effected according to prior known methods. Thus the great economical advantage reducing the normal use of fuel or electric energy requisite during the refining phase to a minimum in this case is attained since the materials to be fed into such a furnace are already in molten state, according to the method herein set forth.

What we claim as our invention is:

1. The method of smelting sulfide bearing raw materials including flotation concentrate which comprises, bringing together said raw material in finely divided form and a controlled volume of air solely at a single position at the beginning of their path of movement, reacting said air with said raw material at the position where they are first brought together, causing said air and said raw material reacting therewith to move smoothly downwardly in a vertical elongated horizontally restricted path, with continuous reduction of the partial pressure of oxygen in the air while increasing the reaction velocity through rise in temperature in the course of the movement to produce at the lower end of said path a molten charge and hot combustion gases, directing said combustion gases in a horizontal path at the base of said vertical path, collecting said molten charge beneath said combustion gases and said horizontal path, and separating said molten charge into layers of matte and slag.



2. The method of smelting sulfide bearing raw materials including flotation concentrate which comprises, bringing together measured quantities of finely divided raw material and air at a single position at the beginning of their path of movement, reacting said air with said raw material immediately on bringing them together, causing said air and said raw material reacting therewith to move concurrently smoothly downwardly in a vertically elongated horizontally restricted path, with continuous diminution of the partial pressure of oxygen from the air as the reaction proceeds, and with increase in the reaction velocity through rise in temperature in the course of movement, to produce at the lower end of said vertical path a molten charge, and hot combustion gases with substantially diminished partial pressure of oxygen, directing said combustion gases in a horizontal path at the base of said vertical path, collecting said molten charge beneath said combustion gases and said horizontal path, and separating said molten charge into layers of matte and slag.

3. The method of smelting sulfide bearing raw materials including flotation concentrate which comprises, bringing together measured quantities of said raw material and air solely at a single position, where the partial pressure of oxygen is at a maximum, reacting said raw material and said air immediately upon their being brought together, causing said air and said raw material reacting therewith to move concurrently downwardly in a vertically elongated horizontally restricted path while continually diminishing the partial pressure of the oxygen in the air and proceeding with the combustion of the raw material, increasing the reaction velocity between the raw material and air through rise in temperature in the course of said downward movement, and along with the diminishing of the partial pressure of oxygen, to produce at the lower end of said path a molten charge, and hot combustion gases with the partial pressure of oxygen in its most diminished state, directing said combustion gases in a horizontal path at the base of said vertical path, collecting said molten charge beneath said combustion gases in said horizontal path, and separating said molten charge into layers of matte and slag.

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