

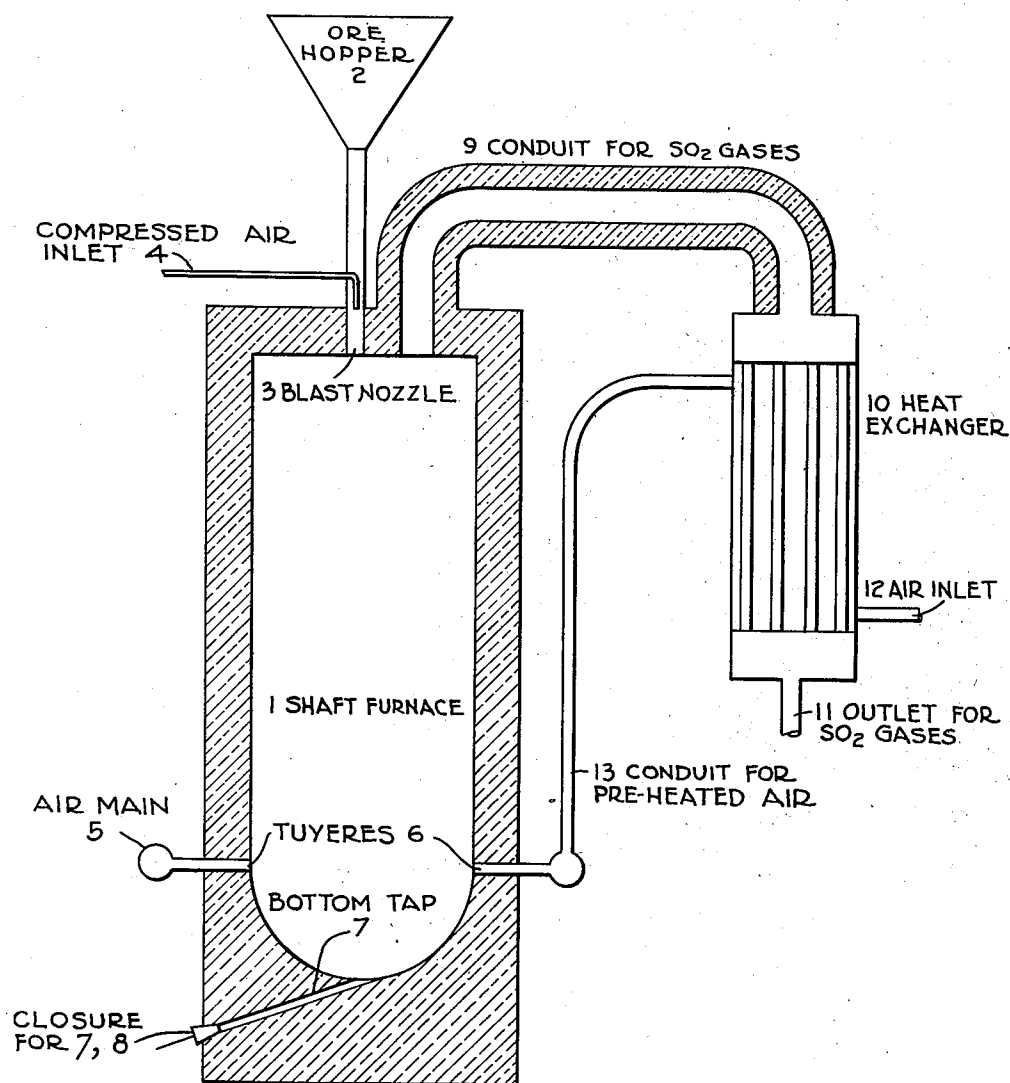
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ORE ROASTING

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ORE ROASTING

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The present invention relates to processes of roasting combustible ores, such as sulfid ores, and particularly to such processes in which a finely divided sulfid ore is suspended in a current of gas and heated, whereby a metal oxide and sulfur combustion products are obtained; and the invention is particularly directed to the control of the conditions of burning sulfid ores in space so that the metallic oxides produced are obtained in the liquid state.

The art of burning pyrites and other sulfid ores is extremely old. In the earlier equipment designed for this purpose, when the recovery of the burner gas produced in the process was the main object, lump pyrites were burned on a grate much as coal is burned. This type of equipment was, however, unsuitable for burning fine material, and consequently there gradually developed a number of so-called "mechanical furnaces" in which the fine material was mechanically rabbled on hearths, and mechanically advanced from hearth to hearth until the sulfur content was reduced to a very low figure. This was an improvement, but was not without drawbacks. In the first place the equipment was costly, and entailed costly upkeep. In the second, owing to the mechanical limitations of the metal rabble arms and rabbles, which could not stand high temperatures, complicated cooling systems were necessary, and weak gas strengths had to be produced, to hold the temperatures down. More lately a new type of mechanical furnace has been developed, in which the fine material is burned in a rotating cylinder inclined slightly from the horizontal. This avoids the metal rabble arms and their complicated cooling, but still requires regulated addition of an excess of air in order to avoid temperatures at which the charge becomes sticky. This in turn means a comparatively weak and cool burner gas.

Some attempt has been made to burn extremely fine pyrites by blowing them into a chamber and burning them much as powdered coal is burned. In this process a stronger and hotter gas can be produced, but other difficulties have arisen. Either the iron oxide residue tends to stick to the side of the chamber and build up there, or, if that difficulty is avoided, the residue consists of small, broken, hollow spheres of iron oxide, which are so small and light that they cannot be charged into a blast furnace without first being briquetted, agglomerated, or sintered, which adds to the cost.

The general idea of burning pyritic material at high temperatures is sound. At high temperatures the rate of reaction is tremendously in-

creased, and consequently the burner can be made small and less costly. Also, when the burner gas is discharged at high temperature its heat content, being at high potential, can more easily be recovered, if that is desired, or dissipated with less equipment, if recovery is not desired.

Many attempts have been made to overcome the difficulties encountered in the formation of semi-fluid, or plastic and sticky cinders.

It has, for instance, been suggested to maintain a pool of liquid water at the bottom of a shaft furnace in which the finely divided ore was blown and burned, the cinders dropping into the water.

Arrangements have been shown in which a blanket of cool air was interposed between the furnace walls and the body of burning ore particles. Other furnaces have been equipped with mechanical scrapers intended to remove the agglomeration of cinders on the furnace walls.

I avoid these difficulties by raising the temperature in the ore combustion zone to a point where the metallic oxide produced is obtained in the liquid state and can be tapped from the burner in molten condition.

I can achieve this in various manners, for instance by mixing with the sulfid ore a fuel of higher calorific value or by using a gas enriched in oxygen, whereby the temperature in the combustion zone is raised.

A more practical, and my preferred, manner of raising the temperature in the combustion zone is to pre-heat the combustion air to a temperature of about at least 500° C. or as high as otherwise practical.

To pre-heat the combustion air I preferably make use of the calories contained in the burner gases obtained.

While in burning pyrites in space with cold air, the burner gases reach a temperature of, for instance, 1000 to 1100° C. I found that by pre-heating the combustion air to about 500 to 750° C. the temperature in the combustion zone reaches about 1500° C. up to 1750° C. and even higher. At these temperatures the pyrites are practically instantly burned to Fe_2O_3 and/or Fe_3O_4 , depending on the oxygen supply and the SO_2 concentration. These oxides of iron melt around 1500° C. and can be collected in liquid form.

The appended figure shows in a diagrammatic manner an apparatus suited for the performance of my invention.

1 in this figure represents a vertical shaft type furnace lined with a basic refractory forming a combustion zone. 2 is a feed hopper for fine sulfid ore. 3 is a blast nozzle operated by a com-

pressed air line 4. 5 is an air main surrounding the bottom of the shaft and communicating with the interior of the combustion zone by means of radial tuyères 6. 7 is an outlet from the bottom of the shaft which forms a crucible, and 8 represents closing means for outlet 7.

From the top of the combustion zone a refractory lined line 9 passes over to a heat exchanger 10, of heat resistant material. This heat exchanger is equipped with a discharge line 11 for the SO_2 ; air inlet 12 brings in the air to be pre-heated and line 13 carries the pre-heated air to the air main 5.

In operating this furnace I first heat the combustion zone to a high temperature by any convenient means and start circulating air through lines 12, 13, 5 and 6. I then blow the combustible ore, such as pyrites, through 2, 3 and 4. The pyrites immediately ignite and raise the temperature in the combustion zone above 1500°C . The iron oxides formed melt and collect in the crucible at the bottom of the shaft, whence they may be tapped off either continuously or intermittently through the run-off line 7. This liquid when it solidifies, produces a dense solid, ideally fitted for charging to a blast furnace for the production of iron. If molten particles of iron oxide strike the sides of the shaft they do not tend to collect, but, because of their fluidity, flow to the crucible at the base.

In order to maintain the process, hot air is regularly introduced through the tuyères 6 in such amount that the exit gas contains only a per cent or two of oxygen. If more air is used it is difficult to maintain the desired temperature.

The hot gases leaving the top of the chamber through line 9 contain all the sulfur of the pyritic material in the form of SO_2 . This gas is passed to a heat exchanger where its temperature is dropped by heat exchange with the incoming air supplied under pressure through 12. Usually, pre-heating the incoming air about 500 to 750°C . suffices to maintain the operating temperature, and the exit gas is cooled about the same amount, the heat capacities of the two gases being about equal.

The hot gas discharged through the line 11 is still at a very high temperature, namely around 1000°C . and can consequently be used for the generation of steam in a waste heat boiler. While heat exchanger 10 is shown of the conventional tubular type, it is obvious that it may be constructed of ceramic material, or may consist of the conventional blast furnace stoves, without departing from the spirit of my invention.

My process is particularly adapted to the use of pyrites recovered from coal, commonly called "coal brasses". This material commonly contains a certain amount of coal, usually around 5%, which cannot easily be removed by the present methods of cleaning. The presence of this coal leads to higher temperatures of burning than when clean pyritic material is used; which in my process is an advantage. Also, owing to the high temperature at which this process operates it is not necessary that the pyritic material be of ex-

treme fineness, though flotation concentrates work admirably.

I claim:

1. The process of producing sulfur dioxide and molten iron oxides which comprises suspending iron pyrites in a combustion zone in a body of pre-heated air in which said pyrites are caused to combine with oxygen, abstracting combustion gases from said combustion zone, passing said combustion gases in heat exchange relationship with an oxygen containing gas such as atmospheric air to pre-heat it, introducing said pre-heated gas into said combustion zone maintaining oxidizing conditions throughout said combustion zone, maintaining the temperature in said combustion zone above 1500°C ., namely above the melting point of said iron oxides, and collecting said iron oxides in the liquid state.

2. The process of claim 1 in which the temperature in the combustion zone is maintained at least at about 1750°C .

3. The process of claim 1 in which the pyrites ore contains a small amount of coal or other carbonaceous material.

4. In a process of roasting finely divided iron pyrites to produce sulfur dioxide and molten iron oxides, the steps comprising suspending iron pyrites in a combustion zone, supplying a heated oxygen-containing gas to the combustion zone, maintaining the reaction under oxidizing conditions and at a temperature above about 1500°C . such that the iron oxides are produced and maintained in a molten condition, collecting the iron oxides in molten condition, and withdrawing the molten iron oxides from the apparatus used for conducting the reaction in a molten condition.

5. In a process of roasting finely divided iron pyrites to produce sulfur dioxide and molten iron oxides, the steps comprising suspending iron pyrites in a combustion zone, supplying a heated oxygen-containing gas to the combustion zone at a temperature of at least 500°C ., maintaining the reaction under oxidizing conditions and at a temperature above about 1500°C . such that the iron oxides are produced and maintained in a molten condition, collecting the iron oxide in molten condition, and withdrawing the molten iron oxides from the apparatus used for conducting the reaction in a molten condition.

6. In a process of roasting finely divided iron pyrites to produce sulfur dioxide and molten iron oxides, the steps comprising suspending iron pyrites in a combustion zone, supplying a heated oxygen-containing gas to the combustion zone, maintaining the reaction under oxidizing conditions and at a temperature above about 1500°C . such that the iron oxides are produced and maintained in a molten condition, collecting the iron oxides in molten condition, and withdrawing the molten iron oxides from the apparatus used for conducting the reaction in a molten condition, the heated oxygen-containing gas being provided by passing combustion gases from the reaction in heat exchange relation to the oxygen-containing gas.

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