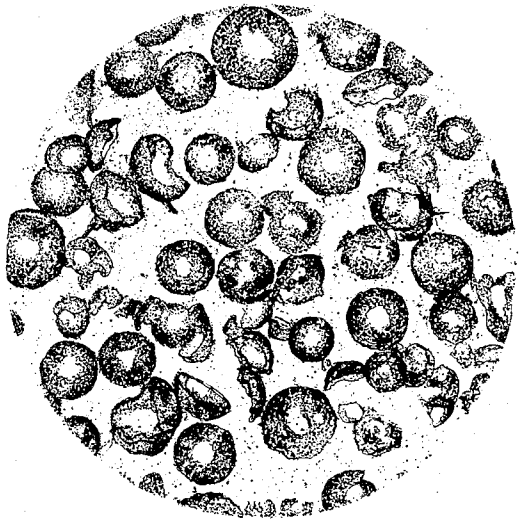
Sept. 17, 1935. H. FREEMAN 2,015,053

IRON OXIDE

Filed Sept. 16, 1932



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Patented Sept. 17, 1935 2,015,053

# UNITED STATES PATENT OFFICE

2,015,053

## IRON OXIDE

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Application September 16, 1932, Serial No. 633,439
In Canada August 31, 1932

2 Claims. (Cl. 23—200)

This invention or discovery is comprised in a novel product, largely comprising a magnetic oxide or oxides of iron in finely divided form.

The flotation process of concentrating copper and zinc from the mixed sulphide ores which are abundant in America, now makes available large quantities of a concentrate of iron pyrite, finely divided and containing about 50 per cent of sulphur.

In my United States patent application, Serial No. 433,471, filed March 5, 1930, (corresponding to Canadian Patent No. 311,130 of May 5, 1931) a suitable apparatus and process are described for treating such concentrates by flash roasting to economically recover sulphur dioxide gas therefrom. I have discovered that when this process is properly carried out, a resulting solid residue may be obtained, comprising a product having unusual properties rendering the same desirable for a wide field of uses.

The accompanying figure of the drawing comprises a copy of a photo-micrograph illustrating a group of particles of said calcine product, which comprises the subject matter of this invention.

A process by which this product may be formed may be described as follows. Of the pyrite now available for the economical manufacture of this product, I prefer flotation pyrite dried to less than 2 per cent or 3 per cent moisture content and containing about 50 per cent of sulphur on the dry basis. I have determined, however, that the ordinary large lump pyrite containing somewhat less sulphur may also be quite successfully used. Such material may be first fed by a regulated feeding device from a storage hopper into a ball mill which may serve as a drier, as a grinder, and also to bring the sulphide into suspension in the air. In the case of lump pyrite, a full charge of balls is used in the mill, but in the case of flotation material a very light charge of balls is preferable, since it is necessary only to break up any agglomeration. Warm air may be admitted into the mill to carry out the material brought into suspension, through a fan, and then into a primary combustion chamber. In this chamber the temperature is preferably maintained above 1100° C. in its middle zone, but the temperature of the burning particles is much higher than this and results in a very rapid and substantially complete removal of the sulphur from the particles which fuse while falling through the atmosphere of the chamber. If care is taken not to burn too much of the material per unit of time and per unit of volume in the chamber, no fluxing of the material on the walls is experienced. In other words, to avoid slag or crust formations in this chamber, preferably the chamber should be of ample size so that no substantial quantity of the falling particles contacts with the walls. For example, I have found that in order to prevent slag or crust formation, the amount of pyrite consumed in the combustion chamber should not exceed two pounds per cubic foot of combustion space per hour. Under these conditions, while a thin crust may form from time to time on the walls, such crust is continually falling away and being renewed without causing any difficulty in the operation of the process.

By regulating the feeding device and the speed of the fan or blower, the rate of feed of ore into the chamber and the amount of velocity of air entering with the ore, may be regulated as desired. An outlet for the gases from the combustion chamber is preferably provided through one or more of the walls near the top thereof. At the bottom of the chamber the side walls preferably are made to converge to an opening through which the solid particles drop on to a conveyor and through which a supplemental supply of air is also drawn up into the combustion chamber, this additional supplemental supply of air being drawn in by suction means acting through the gas outlet. Such supplemental air supply is preferably regulated so that the upwardly moving current of air in the chamber offsets the initial downward velocity of the ore particles, and partially offsets the effect of gravity on the same, so that the descent of the particles through the chamber is retarded.

In starting the process, the combustion chamber is suitably preheated. Then, after the proper temperatures have been created, the process may be continued without use of extraneous fuel and three defined zones are established within the chamber. The upper or heating zone extends some distance downwardly from the nozzle through which the ore is admitted. The atmosphere in this zone is usually largely sulphur dioxide and nitrogen rising from below. The sulphide particles in passing through this zone are heated to ignition and fusion temperature. If there is free sulphur in the ore, some of this may be here volatilized and burned.

In the middle or primary combustion zone, the sulphide particles ignite, this being a zone of intense combustion and complete fusion, in which most of the sulphur is burned to sulphur dioxide with the air introduced along with the sulphide and with some of the air drawn in at the bottom of the combustion chamber. Possibly some of the

iron is also burned. The zone is filled with the characteristic flame of burning sulphur.

In the bottom zone or lower part of the combustion chamber, the highly heated particles meet an excess of comparatively undiluted air drawn in at the bottom of the chamber. As the particles enter this bottom zone, they are individually visible as a shower of brightly sparkling points of light and it is believed that in this zone most of the iron and the residual sulphur is burned. The intense heat of the individual particles indicated by the condition of incandescence, is largely absorbed by the particles at the moment of liberation, in maintaining the fused state of iron oxide, so that the temperature of the atmosphere in this zone is lower than the temperature of the individual particles. As the particles leave this bottom zone, they are chilled and solidified by the incoming air and also serve in some measure to preheat the air. The solid material which passes out counter-current to the incoming air at the bottom of the furnace through the opening, constitutes the novel product of my invention here involved.

The gases passing out at the top of the combustion chamber may be further treated for the recovery and use of the sulphur dioxide and for the utilization of the heat thereof. Suitable processes and apparatus for such purpose are disclosed in the above mentioned patents, which also describe in some respects in further detail the apparatus and process above referred to.

The solid residue or calcine forming the subject matter of this invention may be described as follows. In the condition in which it leaves the combustion chamber, this oxide material is in the form of relatively fine, discrete, separated, fused, highly magnetic particles, many of which appear as broken hollow shells. The material is of a grayish black appearance and contains about 65 per cent of iron, largely combined as magnetite. While it contains the gangue material ordinarily produced in flotation concentrate, it has been found that by magnetic separation, substantially all of such material may be eliminated. If this product is properly produced, according to the above described process the sulphur content thereof may be kept below 0.2 per cent.

This product may be used to advantage for a variety of purposes. For example, it provides a high grade iron ore free from phosphorus and low in sulphur content, which may be sintered or briquetted, or may be used as a raw material for sponge-iron production to be directly smelted in electric furnaces, without the usual cooling of the iron powder and magnetic separation between the reducing kiln and the electric melting furnace. This product may also be used as a frit or flux in the manufacture of brick, such as magnesite brick. In view of the manner in which the product is formed, as above described, the heavy but fine particles are oxidized and fused to a uniform degree. Furthermore, each of the small particles becomes cooled individually before leaving the roaster and largely without contacting with other particles until after solidification has taken place. Accordingly, in its preferred form the product is neither in the form of a sintered mass nor agglomerated, and neither are the fused particles in such form as to render the product dusty and as compared with various finely divided iron oxide products heretofore known. In the formation of a material by the process above described, any fine dust which might be objectionable in the product is carried away with the outlet gases from the combustion chamber so that it does not fall with the desired product through the opening in the bottom of the furnace. Since, despite the fused character of the particles, the material is still of a finely divided and uniform character, it may be readily and uniformly mixed with other finely divided or granular materials whereby it may be used for a variety of purposes which would be impossible or difficult with a fused agglomerated mass of magnetic iron oxide. The finely divided character of the material also facilitates the magnetic separation of the same from the gangue material or any crust materials falling from the walls of the combustion chamber.

The shell-like character of the product is believed to be due to the fact that as the sulphide particles enter the furnace, they rapidly evolve elemental sulphur and in doing so, become puffed up, assuming the form of broken minute hollow balls. This feature of the process has the advantage that each particle thus presents a large surface for oxidation as it slowly falls within the uprising air current. In view of the method in which the product is thus formed, it will be apparent that the material of each particle is treated with uniformity substantially throughout.

It will be appreciated that the sulphide particles are maintained in suspension in the air within the furnace during the entire process of oxidation and by regulating the velocities of the two air supplies, the period of time during which the particles are held in suspension may be made materially longer than would be normally occupied in the gravitation of the particles to the bottom of the chamber, and in this way ample time is provided for thorough combustion.

If it should be desired to form the product for any special purposes in a somewhat agglomerated form, this may be readily done by using a combustion chamber of somewhat less height so that the particles are still incandescent at the point where they fall through the opening at the bottom of the chamber.

While the product comprising this invention and the process and apparatus for forming the same have been described with respect to certain particular preferred and satisfactory examples, it will be understood by those skilled in the art after understanding the nature of the product, that various changes and modifications may be made without departing from the scope of the invention, and it is intended therefore in the appended claims to cover all such modifications.

What is claimed as new and desired to be secured by Letters Patent is:

1. Magnetic iron oxide in the form of fine individually oxidized and fused particles, individually solidified in the form of separate hollow shells.

2. Iron oxide, a substantial portion of which is of the composition of magnetite, in the form of fine individually oxidized and fused particles, individually solidified in the form of separate fragile hollow shells.

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