

UNITED STATES PATENT OFFICE.

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PROCESS OF SMELTING ORES.

No. 869,125.

Specification of Letters Patent.

Patented Oct. 22, 1907.

Application filed September 24, 1906. Serial No. 336,025.

To all whom it may concern:

Be it known that I, HENRY ARDEN, a citizen of the United States, residing at San Diego, in the county of San Diego and State of California, have invented certain new and useful Improvements in Process of Smelting Ores, of which the following is a specification.

This invention is a process of smelting ores and effecting reactions by the agency of a highly heated gas or gases, usually constituting one of the reacting bodies: as a means for heating the gas the electric furnace is preferably employed. The term "ore" is used herein in its broadest sense, as including concentrates, mattes and other sources of metal or metallurgical products.

It has hertofore been proposed to effect reactions, such as the reduction of ores or the production of carbids and other compounds, by subjecting the ore or a suitable charge mixture to the action of a highly heated gas, such as carbon monoxid, water gas or nitrogen. Such methods have not however been commercially successful, mainly by reason of the difficulty of conveying through the medium of a gas a sufficient quantity of heat to secure and maintain a reacting temperature. I have now discovered that by supplementing the heat conveyed by the gas by heat developed by combustion, and preferably by the oxidation of petroleum or petroleum products, such reductions and reactions may be carried out in an economical and highly efficient manner.

I will describe the invention by reference to specific examples thereof, it being understood that the process is not restricted to the particular reactions given by way of example, nor to the specific conditions stated.

For the reduction of iron ores I prefer to proceed as follows: A hematite or other iron ore, preferably mixed with a suitable flux, is charged into a furnace similar in design to an ordinary blast furnace, but having two twyers or sets of twyers at different levels, the lower set situated as usual at the level of the crucible, and the upper set at approximately one-third the height of the furnace above the crucible. Through the upper twyers I introduce petroleum or its heavier fractions, together with sufficient air for complete combustion, that is for the oxidation of the carbon to carbon dioxid. The air for this purpose is highly heated, preferably by causing it to traverse an electric furnace or heater. This heater is preferably of the resistance type, the resistors comprising bars or plates of such character as to be substantially unaffected by the air. I have found that such resistors are conveniently prepared by coating carbon in the form of bars with a refractory layer of carborundum, applied as a paint, using sodium silicate as a binder; or an excellent resistor, particularly where

currents of comparatively high potential are used, comprises a bar of carborundum consisting of grains bound by sodium silicate or otherwise.

It will be understood that I do not restrict myself to the use of any particular material as a resistor, it being essential merely that it should remain substantially unoxidized by air at the temperature employed. The air should be heated to such high degree, and should be introduced in such volume, as will suffice to raise the body of ore nearly or quite to the temperature at which its reduction by carbon monoxid may be accomplished.

The body of ore preliminarily heated as above described, is reduced by highly heated carbon monoxid introduced through the lower twyers. This carbon monoxid is produced by the combustion of petroleum, its heavier fractions, or other hydrocarbon, in a closed furnace of suitable type, the proportion of air being regulated as nearly as practicable to yield carbon monoxid only, together with such vapor of water as may be derived from the oxidation of the hydrogen present. In practice a certain proportion of carbon dioxid is necessarily produced, to reduce which, as well as the water vapor, the gas is passed through a body of carbon in a closed receptacle or furnace, the carbon being maintained at a suitable temperature by inclusion in circuit as an electrical resistance. The resulting carbon monoxid is then heated to such higher temperature as may be necessary to effect the complete reduction of the ore, such heating being preferably accomplished electrically and in the same or other electric furnace. I prefer to employ for this purpose a supplemental electric furnace or superheater, which may comprise resistors of carbon suitably disposed to insure the even heating of the gas. From this furnace the gas passes directly to the ore through the lower twyers and effects its reduction.

I have observed that the reduction is facilitated by conveying into the smelting furnace with the highly heated carbon monoxid, vaporized petroleum, its heavier fractions, or other hydrocarbon. The manner in which the hydrocarbon is vaporized is not material to my invention, the effect desired being to subject the ore to the combined reducing action of carbon monoxid and a hydrocarbon. Thus, the hydrocarbon may be vaporized in the electric furnace above described as employed for superheating the carbon monoxid; or the highly heated carbon monoxid may be utilized for spraying the hydrocarbon or for conveying its vapors into contact with the ore. I prefer however to vaporize the hydrocarbon in an independent furnace, preferably of the electric resistance type, and to convey the vapors through the superheater above described and thence

into the smelting furnace. The quantity of hydrocarbon vaporized may be easily regulated by a suitable automatic feed.

The chief advantages of this process of reduction are its applicability in all cases where petroleum or its products are available, irrespective of the availability or expense of solid fuel; and the increased purity of the product, due to the absence of ash or mechanical impurities in the reducing agent.

The process is furthermore economical and effective and is readily rendered continuous.

I claim:

1. The process of smelting ores, which consists in heating a non-oxidizing gas to a high temperature, commingling with the same a hydrocarbon vapor, and subjecting the ore to the action of the mixture, substantially as described.

2. The process of smelting ores, which consists in heating a non-oxidizing gas to a high temperature by electrically developed heat, commingling with the same a hydrocarbon vapor, and subjecting the ore to the action of the heated mixture, substantially as described.

3. The process of smelting ores, which consists in heating carbon monoxid to a high temperature, commingling therewith a hydrocarbon vapor, and subjecting the ore to the action of the heated mixture of carbon monoxid and hydrocarbon vapors so produced, substantially as described.

4. The process of smelting ores, which consists in burning fuel in presence of the ore, thereby heating the same, and then reducing the ore by a highly heated reducing gas in presence of a hydrocarbon vapor, substantially as described.

5. The process of smelting ores, which consists in heating a body of ore by oxidized products of combustion, and then reducing the same by a highly heated reducing gas containing carbon monoxid and a hydrocarbon vapor, substantially as described.

6. The process of smelting ores, which consists in burning fuel in presence of the ore, thereby heating the same, heating a gas to a high temperature by electrically developed heat, commingling therewith a hydrocarbon vapor and subjecting the ore to said heated gas, substantially as described.

7. The process of smelting ores, which consists in heating a body of ore by oxidized products of combustion, heating a gas to a high temperature by electrically developed

heat, commingling therewith a hydrocarbon vapor, and subjecting the ore to the action of said gas and vapor, substantially as described.

8. The process of smelting ores, which consists in heating a body of ore by oxidized products of combustion, heating a reducing gas to a high temperature by electrically developed heat, commingling therewith a hydrocarbon vapor, and subjecting the ore to the action of said gas and vapor, substantially as described.

9. The process of smelting ores, which consists in heating a body of ore by oxidized products of combustion, heating carbon monoxid to a high temperature by electrically developed heat, commingling therewith a hydrocarbon vapor, and subjecting the ore to the action of said gas and vapor, substantially as described.

10. The process of smelting ores, which consists in heating a body of ore by oxidized products of combustion, oxidizing a liquid hydrocarbon to produce a gaseous mixture containing carbon monoxid, superheating said gaseous mixture, and conveying the same into contact with said heated body of ore, substantially as described.

11. The process of smelting ores, which consists in oxidizing a liquid hydrocarbon to produce a gaseous mixture containing carbon monoxid, passing the mixture into contact with heated carbon, superheating the resulting gas by electrically developed heat, and conveying the same into contact with a heated body of ore, substantially as described.

12. The process of smelting ores, which consists in oxidizing a liquid hydrocarbon to produce a gaseous mixture containing carbon monoxid, superheating said gaseous mixture by electrically developed heat, commingling a hydrocarbon vapor therewith, and conveying the resulting mixture into contact with a heated body of ore, substantially as described.

13. The process of treating ores, which consists in oxidizing a liquid hydrocarbon to produce a gaseous mixture containing carbon monoxid, passing the mixture into contact with heated carbon, superheating the resulting gas by means of electrically developed heat, commingling therewith a hydrocarbon vapor, and conveying the resulting mixture into contact with a heated body of ore, substantially as described.

In testimony whereof, I affix my signature in presence of two witnesses.

HENRY ARDEN.

Witnesses:

G. W. FISHBURN,
B. N. GUNNIS.