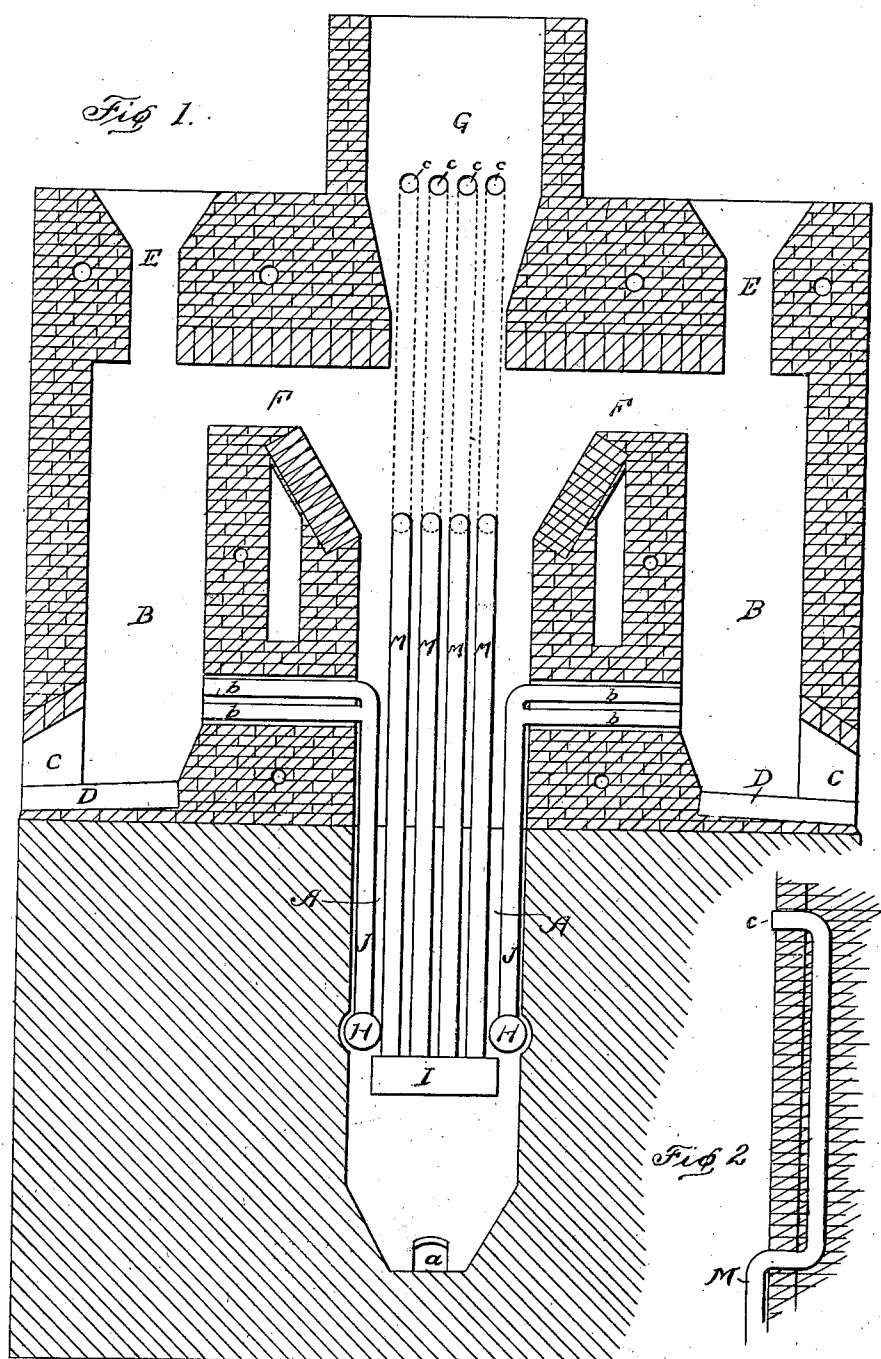


No. 831,160.

PATENTED SEPT. 18, 1906.

J. HERMAN.
PROCESS OF REDUCING ORES.
APPLICATION FILED SEPT. 15, 1905.



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UNITED STATES PATENT OFFICE.

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PROCESS OF REDUCING ORES.

No. 831,160.

Specification of Letters Patent.

Patented Sept. 18, 1906.

Application filed September 15, 1905. Serial No. 278,652.

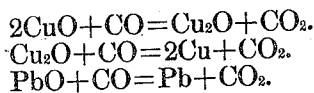
To all whom it may concern:

Be it known that I, JOHN HERMAN, a citizen of the United States, residing at Lincoln, in the county of Lancaster and State of Nebraska, have invented new and useful Improvements in Processes of Reducing Ores, of which the following is a specification.

My invention has reference to a process of reducing ores to a metallic condition; and its utility and advantages will be fully understood from the following description when the same is considered in connection with the accompanying drawings, forming part of this specification, in which—

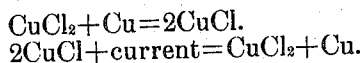
Figure 1 is a vertical cross-section of the novel apparatus which I prefer to employ in carrying out the process, and Fig. 2 is a detail section taken at right angles to Fig. 1 and illustrating the offset in the pipes for supplying air to the shaft down which the ore passes to the reducing compartment or receptacle.

In practicing my process I burn carbonaceous fuel in a suitable compartment and in such manner as to form carbon monoxid, as well as carbon dioxid, and put the resultant hot gases in contact with oxidized ores. I prefer to crush the ores to be treated to a suitable size—say three-fourths of an inch—and to put the before-mentioned hot gases in contact therewith by passing the gases through or over the ores in a compartment other than that in which the carbonaceous fuel burned. In virtue of the step described it will be observed that the oxids are reduced to metallic globes if the temperature is higher than the melting-point of the metal reduced or to a powdery mass if the temperature is low—

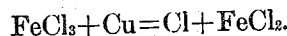


In the event of the ore to be treated bearing copper and being comparatively free from acid-destroying components I prefer to produce the metal at a low temperature and extract the copper through the agency of a solution of cupric chlorid and salt and electrolyze the cuprous chlorid resulting from such operation with a deposition of copper

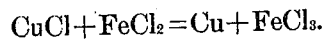
and the regeneration of cupric chlorid in accordance with well-known reactions:



If preferable, the same results may be obtained by substituting ferric chlorid for cupric chlorid, as follows:



By electrolysis:



If, on the other hand, the ore is not adapted to the treatment just described, I heat the ore sufficiently to form metallic globules and concentrate such globules by well-known means.

With a view of utilizing the full heat value of the fuel I inject air into the ore-compartment at a point where it will not interfere with the subsequent reduction of the ore. I prefer to inject this air into a body of descending ore at a point above that at which the ore is reduced and to depend on such air to burn or promote the combustion of the surplus carbon monoxid and liberate heat whereby the ore is heated before entering the reducing part of the apparatus or furnace employed. Another advantage follows from injecting the air as stated, viz.: Any sulfids that are present are oxidized and rendered fit for reduction.

In feeding the ore to the apparatus or furnace I first pass the ore through an oxidizing zone, where many undesirable elements are eliminated, and a reducing zone, in the order named, and then cause the ore to give up its heat to blast-pipes which return the heat to the blast entering the apparatus or furnace.

Subsequent to the operations described the ore is either leached with cupric chlorid or ferric chlorid and electrolyzed or is concentrated according to existing conditions. By merely changing the proportions between carbon monoxid and carbon dioxid the reduction of metals can be well controlled. For instance, by having the ratio of carbon monoxid to carbon dioxid less than two to one iron oxids will not be reduced to metallic condi-

tion. The ratio of the gas may be and preferably is controlled by the depth of the fuel-bed.

My process is materially advantageous, since it provides a means for obtaining copper or other metals without the use of fluxes or acids, and the absence of molten slag renders it feasible to dispense with water-jackets for the furnace. It will also be noted that my process is economical because of the utilization of the inexpensive hot blast to reduce fuel consumption.

I am aware that attempts have been made to reduce oxidized ores by mixing ore and fuel direct. When this is done, however, the portions of ore nearest the points of entry of the blast are necessarily exposed to oxidation, thereby defeating the object of treatment. I am also aware of methods for reducing iron ores; but in these no attempts have been made to isolate different metals nor to render the ores suitable for the treatment proposed, the iron in such cases being left as a metallic sponge. In my method the hot gases are generated in a separate compartment, and their composition is regulated and the temperature to which the ore is heated is regulated by varying the amount of ore passed through the furnace in proportion to the fuel burned.

Referring by letter to the accompanying drawings, illustrating the novel apparatus or furnace which I prefer to employ in carrying out the before-described process, A is an upright receptacle having a discharge *a* at its lower end, through which treated ore passes to a conveyer. (Not shown.)

B B are combustion - compartments or fire-boxes located at opposite sides of the upper portion of the receptacle A and having clinker-doors C adjacent to their bottoms and water jackets or boxes D at such bottoms for the purpose of cooling the clinkers and also having hopper-shaped openings E in their tops, through which carbonaceous fuel is fed, preferably in an automatic manner, and F F are flues or passages intermediate the tops of the combustion-compartments B and the upper portion of the upright receptacle A.

In virtue of the described relative arrangement of the parts it will be observed that the hot gases due to combustion of carbonaceous fuel in the compartments B will pass from the flues F through or over the ores in the receptacle A and will reduce the metallic oxides to metal globes or to a powdery mass, according to the temperature, as before described.

G is a shaft arranged above and adapted to conduct ores to the receptacle A.

H H are heads adapted to be connected with a source for supplying air under pressure. I is a head adapted to be connected with said source of supply.

J J are pipes leading from the heads H upwardly within the lower portion of the receptacle or compartment A and terminating in twyers *b* for supplying the combustion-compartments B with air, and M M are pipes leading from the head I upwardly within the lower portion of the receptacle or compartment A to a point slightly below the plane of the flues F. At such point the pipes M are carried laterally outward into the adjacent walls of the furnace and then upwardly to a point *c* about the proportional distance illustrated above the twyers C, where they are directed inwardly so as to supply the shaft G with air. In virtue of the pipes J and M being carried upwardly in the lower portion of the receptacle or compartment A, it will be observed that the air is supplied to the combustion-compartments B, and the shaft G is preheated, or, in other words, the reduced ore is made to give up its heat, and such heat is returned to the furnace, which is materially advantageous from the standpoint of economy.

In the practical operation of the apparatus described the ore in passing through the furnace occupies an oxidizing zone—i. e., above the plane of the twyers C, where many undesirable elements are eliminated, and then occupies a reducing zone, after which it gives up its heat to the blast-pipes J and M and passes out of the furnace to the conveyer before mentioned.

I claim—

1. The process described which consists in burning carbonaceous fuel in one compartment to form a mixture of carbon monoxid and carbon dioxid in suitable proportions, passing the resultant hot gases through or over ores in another compartment to reduce the metallic oxides of the ores, feeding air to the first-mentioned compartment, and also feeding air heated by the reduced ores to the portion of the second-mentioned compartment remote from the fire.

2. The process described which consists in burning carbonaceous fuel in one or more compartments with a blast heated by previously-treated ore, utilizing the reducing gases from said combustion in the lower portions of said compartment for the purpose of reducing ores to a condition suitable for further treatment, and utilizing the reducing gases from said combustion in the upper portion of a separate compartment, in conjunction with air, for the purpose of oxidizing and heating ores.

3. The process described which consists in
burning carbonaceous fuel in one or more
separate compartments to form a mixture
of carbon monoxid and carbon dioxid in
5 suitable proportions, and passing the result-
ant hot gases through or over ores in another
compartment for the purpose of reducing
metallic oxids to metallic globules, and then
concentrating the said globules by known
10 methods.

4. The process described which consists in
burning carbonaceous fuel in one or more

compartments to form a reducing atmos-
phere, and utilizing the resultant gases for
the purpose of reducing ores in another com- 15
partment, and then concentrating the result-
ing metallic globules.

In testimony whereof I have hereunto set
my hand in presence of two subscribing wit-
nesses.

JOHN HERMAN.

Witnesses:

GEO. EVERETT BAKER,
FRANK L. STRANG.