

UNITED STATES PATENT OFFICE.

CHARLES S. BRADLEY, OF NEW YORK, N. Y.

PROCESS OF REDUCTION OF IRON, &c., FROM THEIR ORES.

No. 829,907.

Specification of Letters Patent.

Patented Aug. 28, 1906.

Application filed July 31, 1903. Serial No. 167,700.

To all whom it may concern:

Be it known that I, CHARLES S. BRADLEY, a citizen of the United States, residing at New York, in the county and State of New York, have invented certain new and useful Improvements in the Reduction of Iron and other Metals from Their Ores, of which the following is a specification.

This invention relates to improvements in the reduction of iron and other metals from their ores; and the object of this invention is to effect such reduction by the interaction of the ores without the intervention of a reducing-blast such as is involved in the usual blast-furnace operations.

It is known that some metals, such as lead and copper, can be reduced by fusing together suitable proportions of their oxids and sulfids, the sulfur and oxygen of the ores combining to form sulfur dioxid, which passes off, while the metal from both kinds of ore remains in substantially pure condition. So far as I know such a process has not been attempted in connection with iron or if attempted has not been commercially successful.

The reaction required in the case of oxid of iron and sulfid of iron is endothermic, and the requisite rate of supply of heat is so great that it cannot be effected in a combustion-furnace either by contact of a blast or by conduction. Moreover, the oxid and sulfid of iron are so refractory that it would be impracticable to heat them by a blast sufficiently to induce this reaction with any certainty of results.

My invention consists in treating the oxid and sulfid of iron or similar refractory oxid and sulfid ores in an electric furnace, the portion of the oxid and sulfid being such that a portion of the sulfur will be expelled and the remainder taken up by the oxygen of the ore, and nearly the whole of the iron or metal will be freed in the metallic state. The process is applicable to other metals of the iron group—such as nickel, cobalt, and manganese.

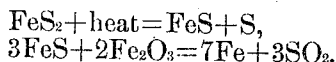
In carrying out my invention I may use any suitable oxid ores, such as hematite or magnetite, and I may use the carbonate in place of the oxid, it being understood that in the heat of the electric furnace the carbonic-acid gas would pass off, leaving an oxid. For the sulfid ingredient I may use pyrites or other sulfid ore or waste products containing

iron sulfid. Some ores contain both oxid and sulfid, and such are readily utilizable in this process, enough being added of the deficient ingredient to make up the proper relative proportion. Waste products containing partly roasted sulfid or sulfid together with sulfate are also utilizable, due allowance being made for the proportions of oxygen present. The silica or other gangue associated with the ores is converted to a slag and the coalescence of the reduced metal facilitated by the addition of a suitable fluxing material—such, for instance, as limestone.

The following is an example of the process: Hematite and pyrites, both in pulverized or crushed state, are mixed in the proportions, say, of two of hematite to one of pyrite, by weight, and are placed with a suitable amount of fluxing material in an electric furnace, and a current of sufficient intensity and volume passed through the mass to melt it and to furnish the heat necessary for the reaction. The temperature required to bring about the reaction is considerably higher than is attained in the ordinary iron blast-furnace. The precise temperature can not be definitely stated, though it is probably in the neighborhood of 3,000° to 4,000° centigrade and possibly higher. After the mass has reached a molten condition the current is increased, thereby raising the temperature. When the temperature of the reaction is attained, the charge boils violently with copious evolution of fumes of SO₂. The current during this boiling period is from three thousand to six thousand four hundred amperes at a pressure of from forty to seventy volts. The sulfur dioxid passes off and may be collected and utilized for the manufacture of sulfuric acid, or otherwise, and the iron from both ores collects at the bottom of the furnace and may be tapped out into suitable molds. It will be understood that carbon, manganese, or other agent may be added to the melted iron to produce any desired quality of metal. The current-terminals if of carbon will naturally be attacked to some extent, but will not carburize the metal appreciably. I prefer to use an alternating current in the furnace, so that there is no resulting electrolytic action. Instead of mixing the materials before heating one material may be heated first and the other added while the heat is continued. By this means an adjustment of

resistance may be obtained, it being understood that the ores are of widely-varying resistance.

The reaction in case hematite and pyrites are used is as follows:



In case of other materials than iron the process would be carried out in similar manner; but it will be understood that it is not applicable to metals which are volatile at the temperatures which would exist in the electric furnace even out of proximity to the electrodes. This excludes not only metals such as copper and lead, which are, moreover, readily reducible by ordinary heating means. It is of course applicable to the production of alloys of such metals. Thus a chrome-iron can be obtained by melting an oxid of chromium with a sulfid of iron or generally a mixture of ores of different metals of the iron or chromium groups or complex ores of such groups, such as pyrrhotite, may be used to give any desired alloy.

Having thus described my invention, the following is what I claim as new therein and desire to secure by Letters Patent:

1. The process of refining ores of a metal of the iron group, which consists in heating to a temperature above that obtained in combustion-furnaces, the sulfid and oxid of the same metal together in an electric furnace, in such proportions that a portion of

the sulfur will be expelled and the remainder will be taken up by the oxygen of the ore.

2. The process of reducing the oxid and sulfid of a metal of the iron group, which consists in heating to a temperature above that of combustion-furnaces, the oxid and sulfid of the same metal by an electric current passed through the same, until they react to liberate sulfur, and form sulfur dioxide and free metal.

3. The process of reducing the oxid and sulfid of iron, which consists in heating to a temperature above that of combustion-furnaces said oxid and sulfid and a fluxing material in an electric furnace, until they melt and react to liberate sulfur, and form sulfur dioxide and free iron.

4. The process of reducing ores of metals of the iron group, which consists in heating in the electric furnace an oxygen-bearing ore of said group with a sulfur-bearing ore of said group together with a fluxing material to a temperature above that of combustion-furnaces, thereby freeing the metal of both kinds of ore.

5. The herein-described process which consists in heating in the electric furnace an oxid of the metal of the iron group and a sulfid of the same metal, and separately collecting the resulting sulfur dioxide and free metal.

CHARLES S. BRADLEY.

Witnesses:

HARRY E. KNIGHT.
J. GREEN.