UNITED STATES PATENT OFFICE.

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METHOD OF PRODUCING METALS.

SPECIFICATION forming part of Letters Patent No. 696,092, dated March 25, 1902.

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To all whom it may concern:

Be it known that I, GUILLIAM H. CLAMER, a citizen of the United States, residing at the city of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a certain new and useful Method of Producing Metals, of which the following is a specification.

One object of the present invention is to provide an expeditious and economical method for producing substantially pure metals.

Another object is to provide for the economical and rapid production of steel either in the form of ingots or perfect castings.

Other objects will appear from the following description.

I shall use the term "basic metal of the alloy" to signify the metal to be produced; and to produce in accordance with my invention a metal in a state of substantial purity from its ores and from alloys or admixtures containing such metal in combination with a metal or metals more electropositive the alloy or admixture is heated in contact with the ore (which may be oxid, sulfid, or chlorid) of the same kind of metal as the basic metal of the alloy, whereby the electropositive metal or metals of the alloy unite or unites with the substance which was in combination with the metal of the ore, thus setting the metal free from the ore and from the alloy in a substantially pure state.

For the sake of further description it will be assumed that the present invention is to be employed for the production of steel. In such case the materials employed would be iron ore, such as magnetite and silicide of iron. In this instance iron is the basic metal of the alloy and silicon the electropositive metal. Upon heating and fluxing the silicon appropriates the oxygen of the ore or magnetite, setting free metallic iron, which unites or mingles with the iron which was the base of the silicide. The result is that the oxid of silicon is taken up by the flux, and the iron derived both from the alloy and the ore remains in a practical state of purity. In the production of low-carbon iron or steel it is advantageous to employ as the source of silicon the high-grade ferrosilicons of commerce. By suitably selecting the ferrosilicons of commerce it is possible in accordance with my invention to produce a low-carbon iron adapted to make homogeneous castings free from the usual imperfections of honeycombing or the formation of blow-holes.

The method of my invention presents a marked advantage over the methods commonly practiced in that the initial temperature required to bring about the reaction is very much lower than is required for melting steel for the same purpose for several reasons—first, because the ferrosilicon melts at a comparatively low temperature, and, second, because the reaction of the silicon with the ore mixture is accompanied by liberation of a great amount of heat. The heat so liberated is sufficient to get the product in such a thin fluid condition as will permit of pouring the same into molds without incurring the risk of chilling or thickening in the operation, and chilling or thickening is a common experience in the manufacture of such castings by known methods.

In practice I select an iron silicide or ferrosilicon of suitable composition for my purpose and melt this in the presence of the needful proportion of iron and oxid as magnetite for satisfying the chemical affinity of the silicon. A slight excess of the iron oxid is advantageous to insure the complete oxidation and removal of the silicon as silica and its incorporation with the slag. A suitable flux is employed in the operation. The ferrosilicon may either be fused and the oxid added to the fused alloy or the ferrosilicon and oxid may be initially charged in a crucible or furnace, as may be most convenient. By a proper selection of the ferrosilicon and its admixture with the appropriate quantity of iron oxid a finished product of low-carbon iron or steel may thus be made in a single operation. Where, however, as will frequently be the case, the iron silicide or ferrosilicon contains a percentage of carbon exceeding that which would be permissible in the product of the reaction, the difficulty is obviated by melting with the ferrosilicon a quantity of wrought-iron or steel scrap to reduce the carbon percentage to the permissible limit. The product obtained after the completed reaction of the silicon with the ore will then have the proper carbon percentage to yield a metal of the desired quality. It is true that a cer-

tain percentage of the carbon is oxidized by reaction with the oxid of iron, but not sufficiently in most cases to produce a soft grade of metal where the original content is high.

By analogy the substitution for the silicide of iron and iron ore of the silicide of another metal, as nickel, and an oxid of that metal, as nickel oxid, would result in the production of that metal or nickel.

It will be obvious to those skilled in the art to which my invention appertains that modifications may be made in details without departing from the spirit thereof. Hence I do not limit myself to the precise mode of procedure or to the precise metals herein specifically set forth; but

Having thus described the nature and objects of my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The art of reducing a metal from its ores, which consists in bringing the ore into contact with a flux and an alloy composed of the same kind of metal as the metal of the ore and an element more electropositive than that metal, heating all said substances and effecting the combination of the electropositive element with the substance with which the metal was combined in the ore, fluxing the compound of the electropositive element, and recovering the metal set free from the alloy and from the ore, substantially as described.

2. The art of reducing iron-oxid ores which consists in bringing a flux and an alloy consisting of carbon and iron and an element more electropositive than iron into contact with the ore, heating all said substances and effecting the combination of the electropositive element with the oxygen of the ore, and recovering the iron of the ore and of the alloy in combination with small proportions of carbon originally contained as impurities in the alloy, substantially as described.

3. The herein-described method of reducing iron-oxid ores which consists in bringing a flux and ferrosilicon into contact with the ore, heating said substances and effecting the combination of the silicon with the oxygen of the ore, fluxing the oxid of the silicon, and recovering the iron of the oxid and of the ferrosilicon, substantially as described.

4. The herein-described method of reducing iron-oxid ores which consists in bringing a flux and ferrosilicon into contact with the ore and with low-carbon iron, heating all these substances and effecting the combination of the silicon with the oxygen of the ore, fluxing the oxid of silicon, and recovering the iron of the ore and of the ferrosilicon along with the low-carbon iron of the charge, as steel, substantially as described.

In testimony whereof I have hereunto signed my name.

GUILLIAM H. CLAMER.

In presence of—

W. J. JACKSON,

K. M. GILLIGAN.