United States Patent Office.

HAYDN M. BAKER, OF WASHINGTON, DISTRICT OF COLUMBIA.

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IMPROVEMENT IN THE MANUFACTURE OF STEEL.

The Schedule referred to in these Letters Patent and making part of the same.

To all whom it may concern:

Be it known that I, HAYDN M. BAKER, of the city of Washington, in the District of Columbia, have invented a new and useful "Process for the Manufacture of Steel from Oxides of Iron and Cast-Iron;" and that the following is a full and exact description thereof.

My invention is based upon the principle of contact of carbide of iron with oxygen and nitrogen-gases in the nascent state, at a temperature which produces the decomposition of the substances furnishing the nitrogen and oxygen. Such a substance is nitric acid, but the aqueous acid is too volatile, and anhydrous nitric acid too expensive and difficult to obtain and apply. I therefore use anhydrous nitrates, as nitrate of potash, soda, lime, magnesia, alumina, baryta, and strontian, or any metallic oxide nitrate. All these substances are decomposed at temperatures not exceeding one thousand degrees (1000°) Fahrenheit, and furnish free oxygen and nitrogen, together with nitric-oxide, nitrous, hypernitric, and nitric acids, the last four surrendering their oxygen to carbon, at elevated temperatures, rapidly.

It is generally acknowledged that nitrogen is an essential element in the formation of steel from metallic iron and the higher carbides of iron, but that of itself it forms no part of the compound known as steel, yet it is a well-established fact that its presence is necessary, although its action may be entirely catalytic.

From repeated experiments, I am convinced that the influences of oxygen and nitrogen in the transformation of cast-iron and high carbides of iron into steel are very much more effective when they are supplied in the nascent state.

One might suppose that passing air through melted cast-iron would be furnishing these elements in the cheapest manner possible, but it will readily occur that the oxygen and nitrogen of the atmosphere are not in chemical combination, but as a mechanical mixture, and when existing in a free state, becomes so expanded with the high temperature and greatly increased specific gravity, that it rapidly makes its escape through the molten mass without sufficient opportunity of contact to exercise the influence it was designed to. I therefore prefer the use of an agent which will furnish these elements gradually and at a sufficiently elevated temperature to induce their union with the elements to be removed.

Many substances furnish nitrogen, as coal, animal matters, cyanides, and ammoniacal salts, but their expense far exceeds that of the nitrates, and at the same time are very much less effective, on account of volatility and easy decomposition at low temperatures.

If these nitrates are used alone, they are very destructive to furnaces or iron-apparatus used as converting-vessels. I therefore use silicic, boracic, or fluoric acids in conjunction with them, or, instead thereof, use silicates, borates, or fluorides; but as silicates, in shape of broken window or bottle-glass, are very easily procured, I prefer their use.

Having described the principles involved, I will now proceed to describe the application of the process.

For the purpose of transforming iron or carbide of iron into steel, I use a reverberatory furnace, and when oxides of iron are used, I first reduce them with the usual excess of carbon, and run the resulting carbide of iron into cold water, to granulate it, and if cast-iron is employed, I remelt and granulate that in the same way.

I now throw two per cent. the weight of batch of broken window or bottle-glass upon the hearth of the furnace, (one may use a great deal more than two per cent., or less, but more is unnecessary, and less would not be so efficient,) and then charge in one-half of the granulated mass to be acted upon, and now two per cent. of the weight of whole batch of granulated iron, of nitrate of soda, then charge in the remaining portion of the batch as quickly as possible, and close the furnace.

I now maintain a moderate furnace-temperature, considerably short of the melting-point of cast-iron, for about one hour.

The above temperature may be described as a red heat. At the expiration of one hour, the temperature may be rapidly elevated considerably above the melting-point of cast-iron, and the molten mass tapped or drawn out, and cast into ingots or ware for machinery, as thought most practicable.

Soon after the furnace is closed, the nitrate charged into it fuses and passes through the interstices of the granulated iron to the hearth or bottom of the furnace, and enters into decomposition, yielding a little free oxygen and nitrogen at first, and later, nitric-oxide, nitrous, hypernitric, and nitric acids, and leaving, as a residue, oxide and peroxide of sodium, which immediately commences to enter into combination with the silicates, yielding a small quantity of oxygen. The nitric-oxide, nitrous, hypernitric, and nitric acids, readily surrender their oxygen to the carbon of the iron, forming carbonic oxide and acid.

As the metal melts, it flows to the bed of the furnace, and floats the silicate or glass up through the unmelted portions of steel, and at the elevated temperatures, and in intimate contact, the said silicates combine with the sulphur, phosphorus, a portion of the carbon, and all the metallic oxides, bringing them to the surface as silicates, and at the same time protecting the melted steel from the action of the air passing through the furnace, thereby avoiding oxidation.

If the nitrate were to be thrown into a hot furnace, it would be nearly all decomposed with such rapidity that the gases designed to effect the transformation would make their escape before the carbide of iron could attain a sufficiently elevated temperature to be influenced by them, and if it were not for the silica or silicates upon the bed of the furnace, the caustic soda left from the decomposition of the nitrate of soda would unite with the silica and alumina of the clay in the bricks or bed of the furnace, forming a fusible glass, which would be floated up by the melting metal, and

thereby expose a new surface of said furnace-hearth or bed to the action of the succeeding batch, and so on.

It is therefore highly proper, for the protection of the furnace, that silicates should be used in conjunction with nitrates.

There is another good reason for it, *i. e.*, that the nitrate becomes mingled with the silicates, and its liberation of the oxygen and nitrogen-gases becomes more gradual than when used alone.

There is still another highly-important reason. The caustic soda from the decomposition of the nitrate enters into chemical combination with the other silicates, and as soda makes a softer and more tenacious silicate than any other substance at high temperatures, it renders the said silicates more yielding to the mechanical action of the melting mass. It also forms a compound which readily absorbs any sulphurets, phosphides, carbon, and all metallic oxides, consequently prevents the insertion, by similar specific gravity or mechanical action, of any foreign bodies in the interstices of the steel, thereby obviating interposition of cohesive contact among the atoms of steel, consequently preserving the natural tensile and elastic force of the metal.

The advantages of this invention are, that it affords a rapid and economical method of transforming the higher carbides of iron into steel of a fine quality.

Claim.

What I claim as my invention, and desire to secure by Letters Patent, is —

The use of alkaline, earthy, and metallic oxide nitrates, in conjunction with silica or silicates, fluorides, and borates, or mixtures of same, or any other vitreous substances, for the purpose of transforming the higher carbides of iron into steel, in the manner herein described, or by any other method substantially the same.

Witnesses: HAYDN M. BAKER.

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