G. H. BENJAMIN.

ELECTRIC SMELTING.

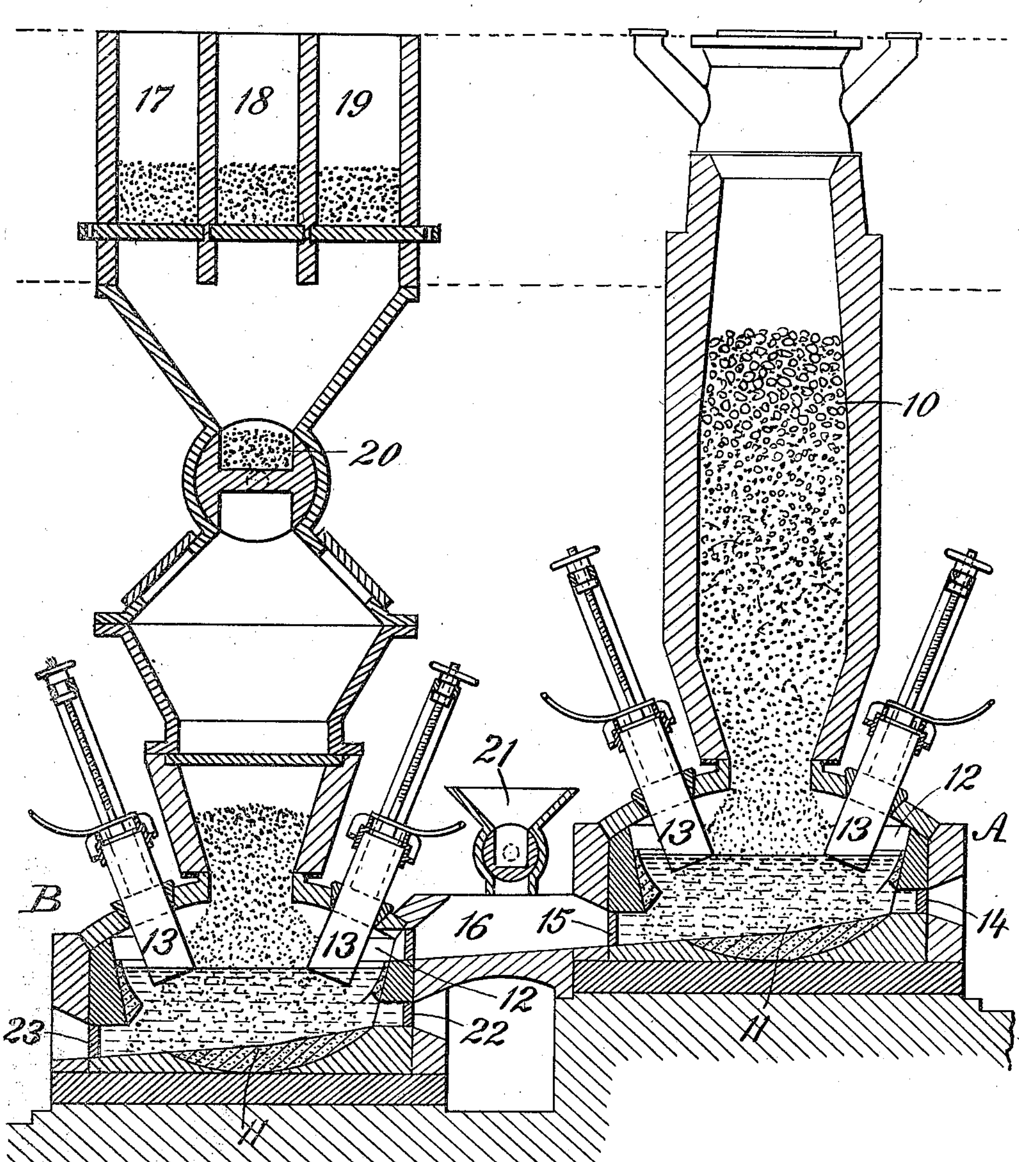
APPLICATION FILED NOV. 6, 1911.

1,051,065.

Patented Jan. 21, 1913.

2 SHEETS—SHEET 1.

FIG. 1.



Witnesses:

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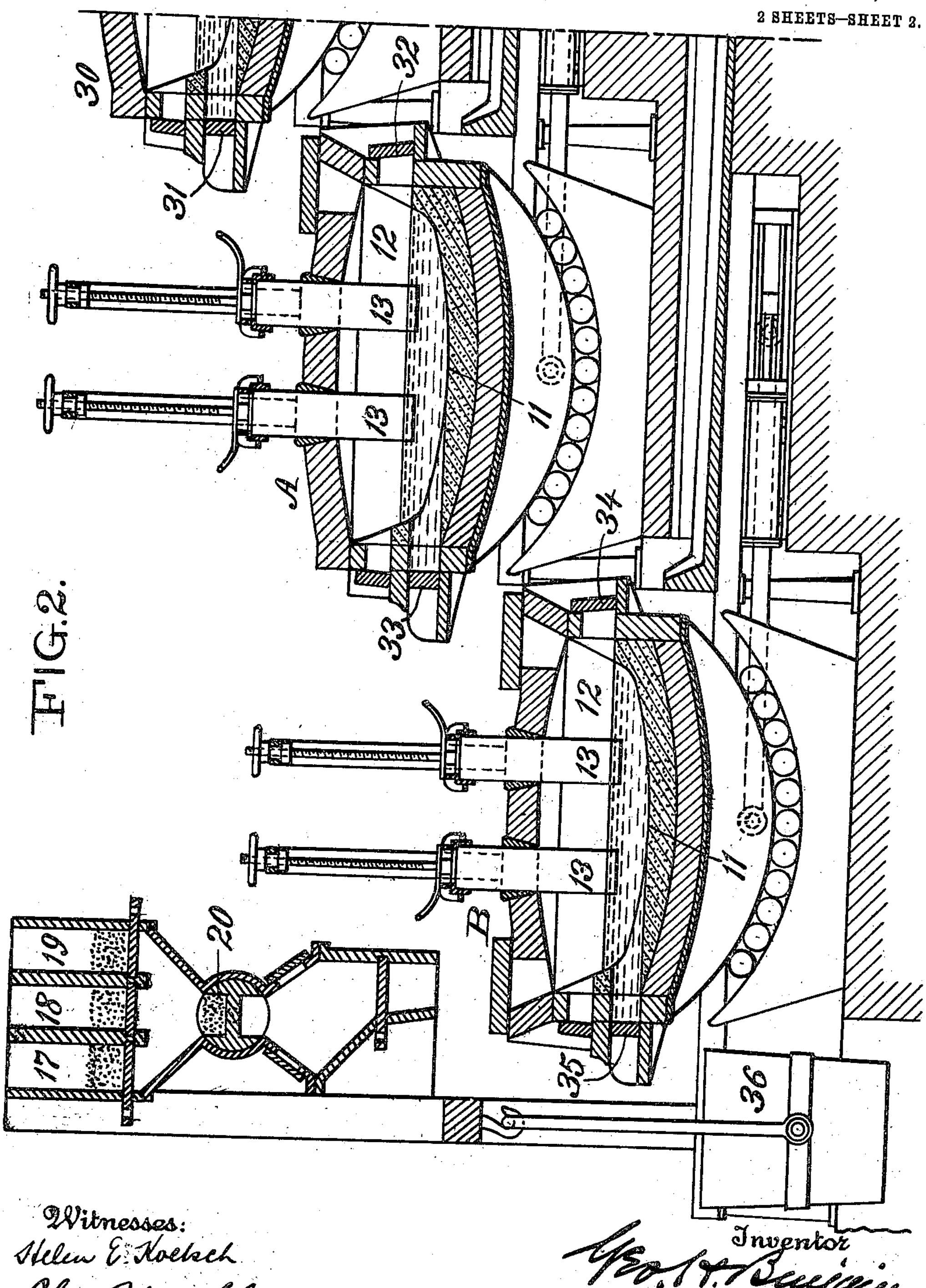
2 SHEETS—SHEET 2.

FIG. 2.



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UNITED STATES PATENT OFFICE.

GEORGE HILLARD BENJAMIN, OF NEW YORK, N. Y.

ELECTRIC SMELTING.

1,051,065. Specification of Letters Patent. Patented Jan. 21, 1913.

Application filed November 6, 1911. Serial No. 658,776.

To all whom it may concern:

Be it known that I, George Hillard Benjamin, a citizen of the United States, residing at New York city, in the county and State of New York, have invented certain new and useful Improvements in Electric Smelting, of which the following is a specification.

The purpose of my invention is to improve electric smelting as carried out in the manufacture of steel and other metals.

My invention primarily depends upon the observed fact that in the treatment of steel in an electric furnace for the removal of phosphorus, it has been found practically impossible to remove substantially all the phosphorus and yet leave the required amount of carbon associated with the iron. The reason for this appears to be that the lime introduced into the furnace, has greater affinity for the carbon than for the phosphorus. Under the high temperature of the furnace there will be formed in the preliminary stages of the treatment, calcium carbid, calcium phosphid and calcium silicid. If the treatment is carried on for any length of time, there will be continuous combination of the carbon with the lime, the phosphorus, however, remaining uncombined until all of the carbon is absorbed, when combination with the remaining phosphorus will take place.

My invention has for its object to overcome the objection stated, and effect smelting in such a manner that in the case of steel, definite grades of steel may be obtained, and in the case of other metals, definite combinations.

The accompanying drawings illustrate apparatus which may be used to carry my invention into effect. I wish it understood, however, that these drawings are merely illustrative of types of such apparatus as may be employed.

In the drawings, Figure 1 illustrates in vertical section, such a construction as may be employed in converting an ore into a finished body, and Fig. 2 illustrates, in vertical section, such a construction as may be employed in converting a fluid body into a finished body.

To carry my invention into effect, I may proceed as follows, reference being first had to Fig. 1. Roasted ore is charged into a stack 10 of the furnace marked A, and falls upon the hearth 11. Situated within the smelting chamber 12 of this furnace, are electrodes 13 connected to any suitable source of electricity. Simultaneously with the introduction of the ore, there is charged such fluxes as are known to be useful in producing the reduction of the ore in electric furnaces, preferably, among others, lime and carbon, which, as described in my prior Patent No. 834,656 dated October 30th, 1906, will combine, together with the silicon and phosphorus carried by the ore, to form calcium carbid, calcium phosphid and calcium silicid, all of which reactions are now well understood. In late experiments I have found it advisable to introduce magnesia, which combines with the nitrogen present to form magnesium nitrate. The furnace A is provided with a slag door 14, through which the slags may be withdrawn, and with an exit door 15 through which the contents of the furnace may be continuously or intermittently discharged into a passageway 16, communicating with a second furnace B. The furnace B is substantially the same in construction as the furnace A at the right, with the exception that it is not provided with the stack 10. Situated over this furnace are bins 17, 18—19, adapted to contain such materials as it may be desired to incorporate in the steel, as for instance, carbon, nickel, vanadium, or other materials. Under the bins is a hopper 20, through which a charge may be accumulated to be subsequently dumped into the molten bath on the hearth of the furnace B. 21 indicates a hopper arranged over the passageway 16 through which any desirable material may be charged into the molten metal as it flows from the furnace A to the furnace B. 22 and 23 are respectively slag and exit doors from the furnace B. In carrying out my process I charge the ore (roasted, concentrated or otherwise) together with the fluxes, into the stack 10, and after it has been sufficiently heated, on to the hearth of the furnace A, and therein subject the combined bodies to the temperature effects of a transmitted electric current until all of the carbon (except that which forms a constituent element of the electrodes) silicon and phosphorus present have combined with the introduced lime. In case magnesia has been charged into the furnace, until the whole or a portion of the nitrogen present, has combined with the magnesia. The time required to effect the combinations will depend somewhat upon the nature of the charge and construction of the furnace—usually from five to seven hours will be required. After the combinations above outlined have been effected, the metal on the hearth will be substantially pure iron. At this time the exit door 15 of the furnace A is opened, and the substantially pure iron caused to traverse the passageway 16 and be discharged upon the hearth of the furnace B. As pure iron is not readily maintained fluid, or sufficiently fluid to cause it to run freely or to be readily mixed with the materials introduced in the furnace B as hereafter described, I prefer to introduce into the iron, before it leaves the furnace A or as it traverses the passageway 16, a certain amount of powdered silica, which tends to increase the fluidity of the iron. If the temperature of furnace A is, however, sufficiently high, this step may be omitted. After the pure iron has been discharged into the furnace B and therein subjected to the temperature effects of a transmitted electric current of this furnace, I introduce into the iron, a definite amount of carbon, or a definite amount of carbon and any other material, such as nickel, or vanadium, as may be required to produce steel of the character desired. Further, I may add an acid or an alkali, or other suitable material, as a catalytic agent, to aid in bringing about a uniform mixture and combination of the iron bath and the introduced materials. In practice it has been found, that in the furnace B it is not necessary to maintain the same degree of temperature as in the furnace A, and probably for the reason that in the furnace A the temperature must be sufficiently high to break down the chemical bonds existing between the materials combined in the ore and to effect the required combinations with the lime, whereas in furnace B all that is required is to bring about the combination of the carbon with the iron and the alloying or amalgamation of the nickel, vanadium or other material with the iron and carbon. Any slags which form in the furnace B may be drawn off through the door 22 and the finished metal through the exit door 23. The time of treatment in the furnace B will depend largely upon the refractory character of the introduced materials—generally from three to five hours will be found sufficient.

The process as described involves an intermittent action, that is to say, first breaking down the materials in furnace A, and subsequently building up the materials in furnace B. It is within the contemplation of my invention, however, to make the process a continuous one, that is, that the pure iron as it forms on the hearth of furnace A should continuously run into furnace B. It is likewise within the contemplation of my furnace to perform all of the operations required, in furnace A. In practice, however, it has been found difficult to accomplish the same results, and for the reason that the slags which accumulate upon the walls of the furnace, tend to become reincorporated with the iron at the time when the materials like carbon, nickel and vanadium are reintroduced. I therefore prefer to carry out the operations in two furnaces as described.

Referring now to Fig. 2, my improved method is carried into effect as follows: Basic fluxed steel is accumulated in the mixer 30 and discharged through door 31 from the mixer into the tilting furnace A, and therein subjected to the temperature effects of a transmitted electric current, and the introduced fluxes, such as have been described. This furnace is provided with a slag door 32 and an exit or pouring door 33. After the required reactions have been effected, the furnace is tilted and the fluid metal discharged into the furnace B, where it is again subjected to the temperature effects of a transmitted electric current. Into the metal in this furnace, which has been described in the furnace shown in Fig. 1 as pure iron, there is introduced carbon, nickel or vanadium, or any other material with which it is desired to combine the iron. Fluxes and catalytic agents may be introduced. The furnace may be tilted to aid in effecting the combinations. In case of the formation of a slag, it may be discharged through the slag door 34, and the finished metal through the exit door 35, into a ladle 36.

In carrying out the operations described, the furnaces in Fig. 1 and Fig. 2 may have acid or basic linings, depending upon the materials treated. I do not limit myself in any wise to the character of the lining, fluxes or catalytic agents which may be introduced, or to the temperatures which may be employed, provided they are sufficient to effect the chemical actions and reactions described. What I wish to have understood is that I believe I am the first to recognize the fact that it is impossible to obtain a uniform grade of steel in an electric furnace, and at the same time reduce the phosphorous constituent in an amount which will not be objectionable in the finished product, and to suggest a method of treatment and means by which the required results can be obtained.

I have described my improved process as employed in the manufacture of steel. Manifestly it may be employed in the treatment of other metals, such as zinc and copper, or in the manufacture of alloys and generally in metallurgical operations where it is desired to free the original ore or metal from bodies, before effecting combinations with other bodies.

In describing the application of my improved method as relating to the furnace construction as shown in Fig. 1, I have stated that the materials discharged into the stack 10 are heated, which heating it will be seen is due to the heat generated due to a transmitted electric current ascending the stack.

Having thus described my invention, I claim:

1. The herein described process which consists in subjecting a charge containing carbon and phosphorus to the action of fluxes containing lime in excess of that required to combine with the carbon present, and to the high temperature effects of a transmitted electric current, until substantially all of the carbon and phosphorus present has been combined with the lime, then subjecting the metal after separation of the slag, to the high temperature effects of a transmitted electric current and while so heated introducing such materials as are required to produce the product desired.

2. The herein described process which consists in subjecting a charge containing carbon and phosphorus first to the action of heat and fluxes, then to the action of the high temperature effects of a transmitted electric current, and fluxes containing lime in excess of that required to combine with the carbon, until substantially all of the carbon and phosphorus present has been combined with the lime, then removing the slag, then subjecting the resultant metal to the high temperature effects of a transmitted electric current, and while so heated introducing such materials as are required to produce the product desired.

3. The herein described process which consists in introducing a charge containing carbon and phosphorus into a furnace, then subjecting the material to the action of basic fluxes containing lime in excess of that required to combine with the carbon present, and to the high temperature effects of a transmitted electric current, until substantially all of the carbon and phosphorus present has been combined with the lime, then removing the slag, then subjecting the resultant metal to the high temperature effects of a transmitted electric current and while so heated introducing carbon and a metal.

4. The herein described process which consists in subjecting a charge containing carbon and phosphorus to the action of fluxes containing lime in excess of that required to combine with the carbon present, and to the high temperature effects of a transmitted electric current, until substantially all of the carbon and phosphorus has been combined with the lime, then removing the slag, then subjecting the resultant metal to the high temperature effects of a transmitted electric current but of relatively lower temperature than that to which it was first subjected, and while so heated introducing such materials as are required to produce the product desired.

5. A step in the process described, which consists in eliminating substantially all of the carbon and phosphorus from a charge containing iron, carbon and phosphorus without effecting oxidation of these bodies, before introducing the carbon constituent required to produce a definite grade of steel.

6. A step in the process described, which consists in subjecting a charge containing iron and nitrogen to the high temperature effects of a transmitted electric current and to the action of magnesia sufficient in quantity to satisfy the nitrogen present, whereby chemical combination with the nitrogen is effected, and the nitrogen removed from the charge treated.

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

GEORGE HILLARD BENJAMIN.

Witnesses:
HELEN E. KOELSCH,
ELI WEILL.