P. BUNET.
ELECTRIC FURNACE.
APPLICATION FILED NOV. 24, 1914.

1,145,748.

Patented July 6, 1915.
2 SHEETS—SHEET 1.

Fig. 1.

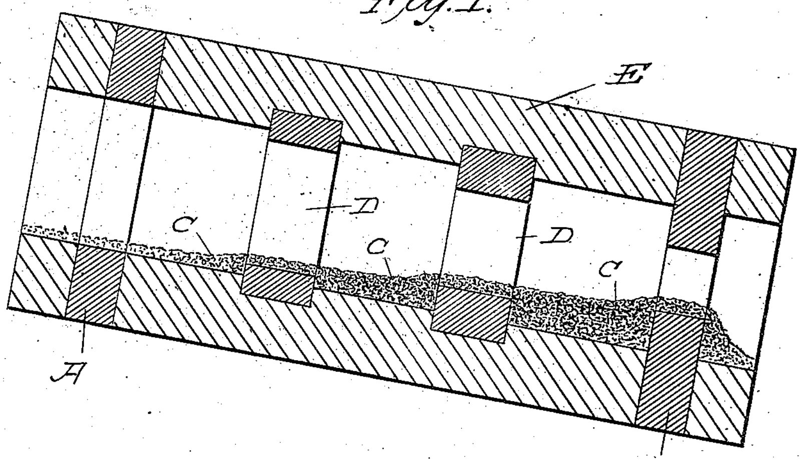
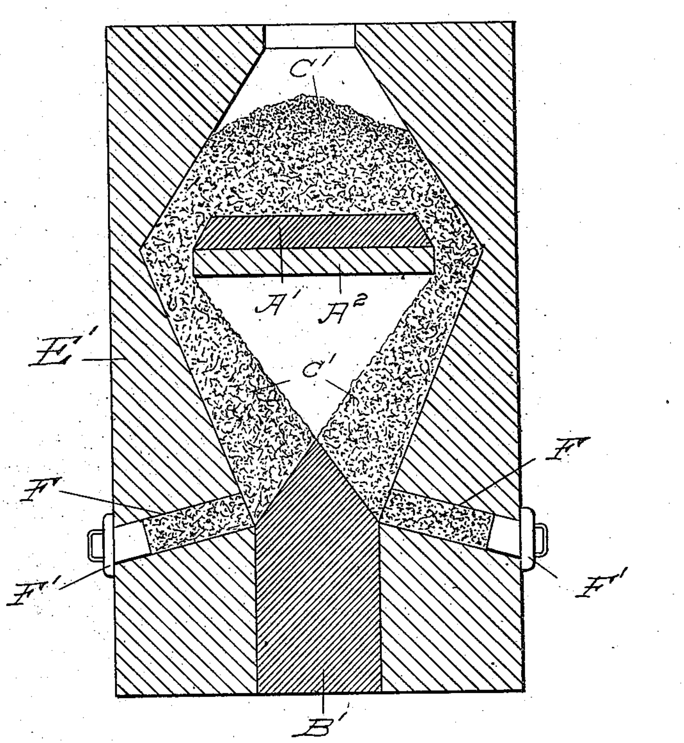


Fig. 2.



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2 SHEETS—SHEET 2.

Fig 3

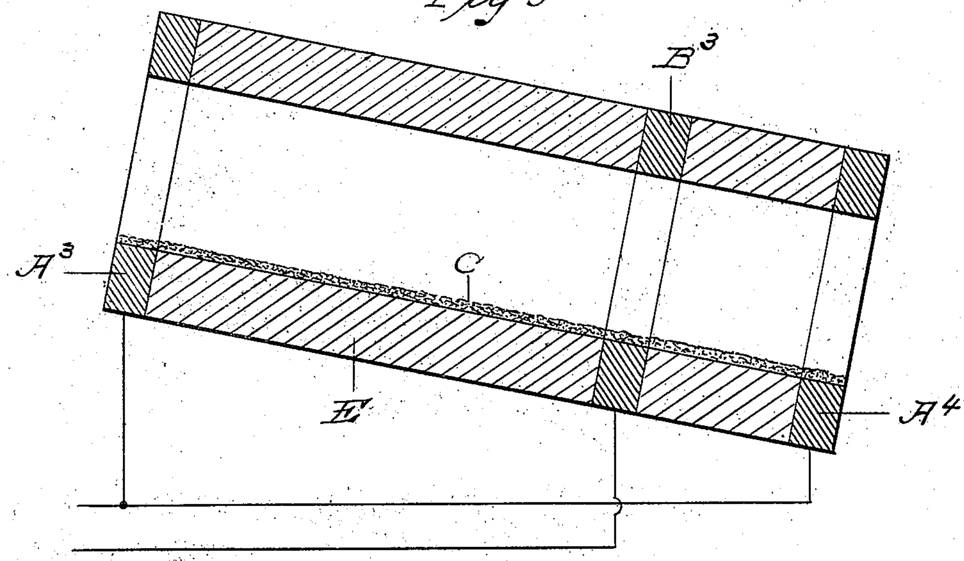
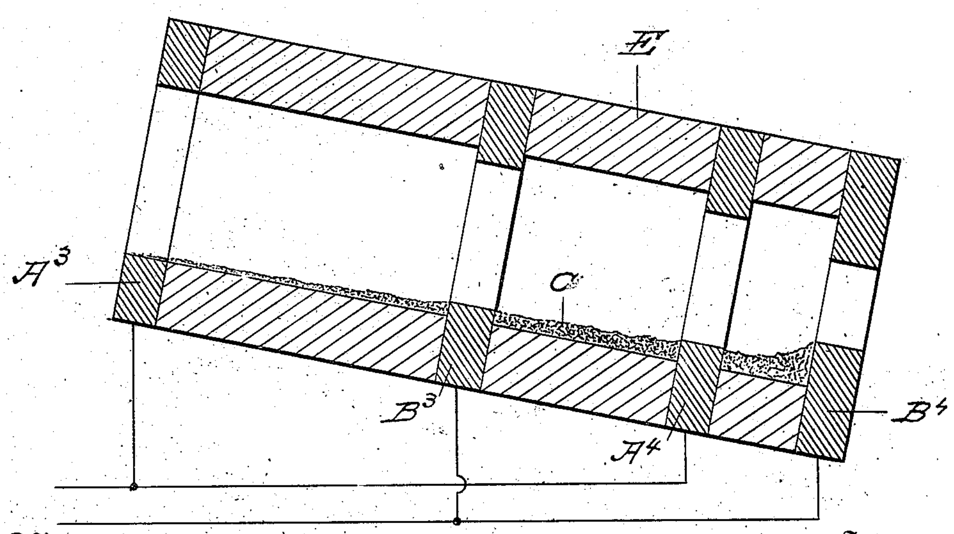


Fig. 4



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UNITED STATES PATENT OFFICE.

PAUL BUNET, OF WHITNEY, NORTH CAROLINA, ASSIGNOR TO SOCIÉTÉ GENERALE DES NITRURES, OF PARIS, FRANCE.

ELECTRIC FURNACE.

1,145,748. Specification of Letters Patent. Patented July 6, 1915.

Original application filed May 9, 1913, Serial No. 766,461. Divided and this application filed November 24, 1914. Serial No. 873,781.

To all whom it may concern:

Be it known that I, PAUL BUNET, of Whitney, Stanly county, North Carolina, and a citizen of the Republic of France, have invented certain new and useful Improvements in Electric Furnaces, of which the following is a specification.

This invention relates to a revolving electric furnace, more particularly adapted to carry out a process for the manufacture of aluminium nitrid by the method which consists in heating in presence of nitrogen or of gases containing the latter, a mixture of alumina or aluminous substances and carbon in an electrical resistance furnace in which the material under treatment itself serves as the heating resistance.

My invention consists in the construction of the continuous electrical furnace so as to effect the advance of the mixture of the above substances containing an excess of carbon or other conductive substances in sufficient quantity to insure the passage of current in spite of the reactionary losses of carbon, necessary to the transformation of the alumina into aluminium nitrid.

My invention may be embodied in furnaces of different types, such as hereinafter described. The first type of furnace is arranged in such a way that the thickness of the layer of material goes on increasing in proportion as the latter advances through the furnace. In this way the sectional area increases in the parts of the furnace where the mixture becomes poor in carbon in consequence of the reaction, and there is, therefore, always at every cross-section of the furnace a sufficient quantity of conductive material to insure the regular passage of the current. The second type of furnace is so arranged that at intervals along its length there are connections or electrodes for conveying the current, which are connected alternately to the two poles of the generator or supply. In this way the furnace is divided into a number of elements or sections through which the material under treatment passes successively; the length of each section can be selected in accordance with the state of conductivity of the material treated therein. These two types of furnace can evidently be combined.

The accompanying drawing shows by way of example various forms of construction of furnaces for carrying out the process.

Figure 1 is a longitudinal section, illustrating an inclined revolving electric furnace, according to my invention; Fig. 2 is a vertical section of a stationary form of furnace; Figs. 3 and 4 are diagrammatic sections of two modified forms of revolving electric furnaces.

Fig. 1 shows a revolving furnace which is slightly inclined so as to allow the substances introduced into the furnace to advance therethrough in a continuous manner, after the general method described in the Serpek Patent, No. 1,030,929, July 2, 1912. The gaseous current containing nitrogen circulates, as usual, in the contrary direction to the materials. The electric current is led to two annular conductors A and B of which the lower one B projects inside the furnace so as to form a diaphragm and to retain the material C traveling through the furnace. As explained above, in proportion as the material advances through the furnace and the transformation into nitrid becomes very complete, the thickness of the layer is increased, in this way allowing of maintaining at every cross section the quantity of carbon sufficient to insure the regular passage of the current in spite of the losses resulting from the reaction. Matters can, therefore, be so arranged that the resistance and consequently the evolution of heat are approximately constant throughout the length of the furnace. In order to heat up the furnace and to facilitate the passage of the current at the start, the operation may be commenced by passing carbon alone through the furnace; the mixture to be treated is then gradually added. There may be arranged in the furnace at certain intervals conductive rings D fitted in the refractory lining, E, and projecting or not. In this way there are formed in the furnace zones of less resistance which facilitate the passage of the current. This arrangement allows the furnace to be made of any length, greater in proportion to the size of the projection of the conductive rings D.

Fig. 2 of the drawing shows a stationary furnace based upon the same principle; the furnace is vertical and the current is led to the two electrodes A^1 and B^1. The material poured upon the side of the electrode A^1 falls upon the lateral walls of the furnace forming a sloping bank, the sectional area of which increases toward the lower electrode B^1. The electrode A^1 is insulated on its underside by an insulating support A^2 in order that the current shall pass with certainty through the mixture O^1 under treatment. The electrode A^1 and its support A^2 are movable and can be raised or lowered; in this way the furnace is regulated by increasing or decreasing the separation of the electrodes and the areas for the passage of the mixture. Openings F, closed by plugs F^1, are formed at the bottom of the furnace at various points in the periphery to allow the material to be withdrawn.

Fig. 3 is a longitudinal section of a furnace of the second type, in which an intermediate electrode or terminal B^3 is arranged between the extreme electrodes A^3, A^4, all these electrodes being formed as conductive rings or annuli. Fig. 4 is a longitudinal section of a similar furnace, having two intermediate electrodes; in this case some of the conductive rings forming terminals have been arranged to project internally of the furnace so as to afford walls or diaphragms according to the principle of the first type of furnace above described. In the arrangement of Fig. 4, the conductive rings A^3, A^4 are connected to one of the poles of the electrical generator while the alternate rings B^3, B^4 are connected to the other pole. In these two figures, E still indicates the refractory lining of the furnace and C the material in course of its advance therethrough. The current of nitrogen circulates in the opposite direction as usual.

The use of intermediate electrodes and the possibility of selecting their separation as desired, form a practical method which allows latitude for regulating in accordance with the requirement of manufacture one or more of the following factors which are all of importance in the management of revolving electrical furnaces, viz:—voltage, resistance, current, intensity, length and inclination of the furnace, proportion of the conductive material added to the mass in reaction, total expenditure of energy and of heat and division of the matter along the various elementary sections of the furnace. In particular, by reducing the length of the path traveled by the material between two successive electrodes, the resistance is diminished. It becomes possible, therefore, to reduce the quantity of conducting material added to the materials in reaction in order to insure the passage of the current; this allows of diminishing the expenditure of energy devoted to the heating of these conductive materials and to obtain at the end of the operation a product which is not surcharged with inert material and is, therefore, richer in nitrid.

Instead of reducing the proportion of conductive matter added, the length of the furnace may be increased without reaching a resistance deleterious to the satisfactory carrying out of the operation. In this way there is obtained a result analogous to that which is produced by the conductive rings D, which are not connected to the poles of the generator in the furnace shown in Fig. 1. Again, by bringing closer together two consecutive electrodes, the heat may be concentrated in a given zone as desired, for example in the final zone which is the poorest in carbon and in which the current has most difficulty in passing.

Another peculiarity of the type of furnace, which presents an important practical advantage, lies in the fact that it realizes automatically the regulation of the intensity of the current, and, therefore, of the quantity of heat which passes through the different elementary sections of the furnace. Indeed, if for any reason the intensity of the current increased abnormally at one of the sections of the furnace, to the detriment of the others, there would be produced at that point a larger quantity of heat; this would increase the reaction of the carbon and alumina. There would result an elimination of carbon in the state of carbon monoxid and the reacting mixture would become less conductive; this would cause a reduction in the intensity of the current in this section and so reëstablish the general equilibrium.

As has been said before, it is advantageous to combine the use of intermediate electrodes with the system of furnace-diaphragms as shown in Fig. 1; such an arrangement is illustrated in Fig. 4. In this way it becomes possible to combine the useful effects of the methods of regulation of the two systems, according to different requirements. In particular, it becomes possible to vary as desired in each elementary section of the furnace, the thickness of the layer of material under treatment, and the extent which it occupies between the consecutive electrodes.

As stated above, the material delivered to the furnace may be a mixture of alumina and carbon with an excess of the latter over or above the quantity necessary to the reaction. By way of example, it may be stated that there may be introduced into the mixture a quantity of carbon double that which is necessary to the reaction. A part or the whole of this excess of carbon may, however, equally well be replaced by one or more substances which are good electrical conductors, the metals for example. Among these substances, it is of advantage to select those which possess at the same time the property of actifying the reaction of formation of nitrid. One may, for example, use iron, copper, nickel, manganese or their ores or again alloys of these metals, such as ferro-nickel, ferro-silicon, ferro-manganese, etc. The use of iron or of certain of its alloys has the further special advantage of allowing it to be separated magnetically from the aluminum nitrid at the end of the operation. Since iron oxid is already found in greater or less proportions in certain aluminium ores, (in particular the ferruginous bauxites, for example), it will be sufficient in case of the use of these ores to complete by additions the quantity of iron required to obtain the desired conductivity of the mass under treatment. The material introduced into the furnace (whatever be its composition and whatever be the type of furnace employed) may be in the pulverulent state or in the form of agglomerates; it may again be in the form or agglomerates containing only the alumina or aluminous material and the carbon necessary to the reaction, while the carbon or other conductive material intended to insure the desired conductivity is added separately. In case the conductive material added consists wholly or in part of carbon, the atmospheric air may be used directly as the gas of the reaction; the excess of carbon contained in the material may then serve at the end of the operation and beyond the electrical zone to deprive this air of its oxygen.

The processes which I have above described as capable of being carried out in my furnaces form the subject of a separate application filed by me May 9, 1913, Serial No. 766,461, the present application being a division of said prior application.

I claim as my invention:

1. An inclined revolving electrical furnace, having two conductive crowns, and means for supplying current thereto, the lower crown projecting internally of the furnace, in such a way as to increase the thickness of the layer of material treated toward the outlet end.

2. An inclined revolving electrical furnace having conductive rings and means for supplying current thereto and intermediate conductive rings interposed at different points in the refractory wall of the furnace.

3. An inclined revolving electrical furnace in the length of which are arranged electrodes which are connected alternately to each of the two poles of a generating source, to divide the furnace into a number of elementary sections, the length of each of which can be selected according to the state of conductivity possessed by the material at the time of passing this section.

4. A slightly inclined revolving continuous furnace, having electrodes spaced along the length of the furnace, and in which the separation of the electrodes diminishes in the direction of the advance of the material, that is to say, according as the latter becomes less conductive as the reactions go on.

5. An inclined revolving electric furnace having electrodes in the form of diaphragms with decreasing orifices for the passage of the material, to vary the thickness of the layer of material under treatment and the extent which it occupies between the electrodes.

6. In an inclined rotary electric furnace, a lining composed of refractory conducting rings and refractory nonconducting material between the rings to insulate the same from each other; and electrical connections for the rings.

7. In an inclined rotary electric furnace, a lining composed of carbon rings and refractory non-conducting material between the carbon rings to insulate the same from each other; a conductive charge bridging the rings and electrical connections for the rings.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

PAUL BUNET.

Witnesses:
W. F. Rockwell,
W. P. Marseilles.