No. 718,891. PATENTED JAN. 20, 1903.

E. G. ACHESON.

METHOD OF REDUCING METALLIC OXIDS.

APPLICATION FILED DEC. 4, 1900.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

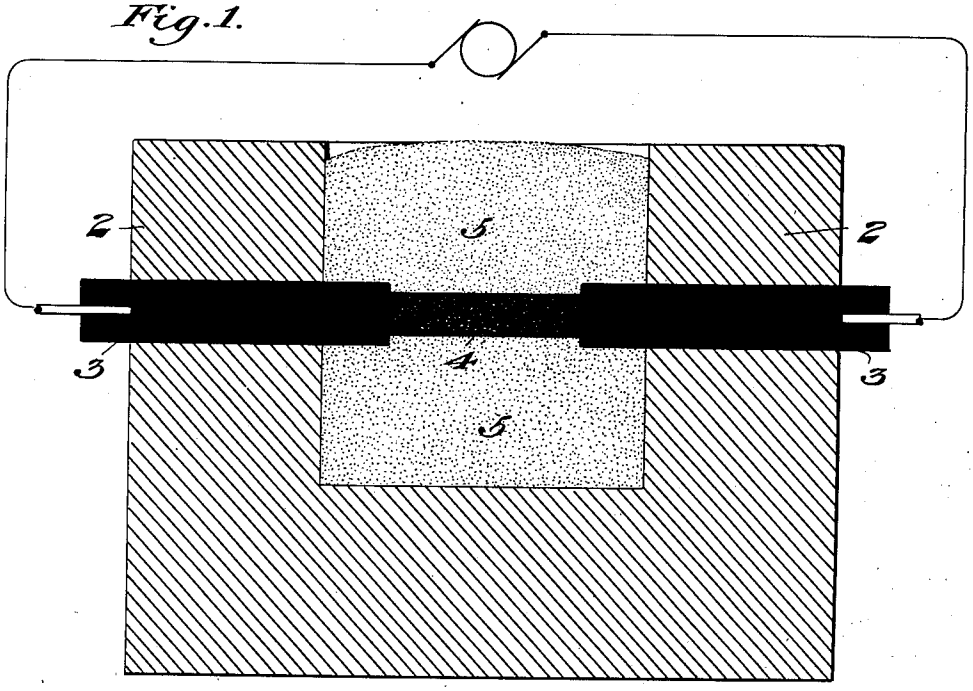
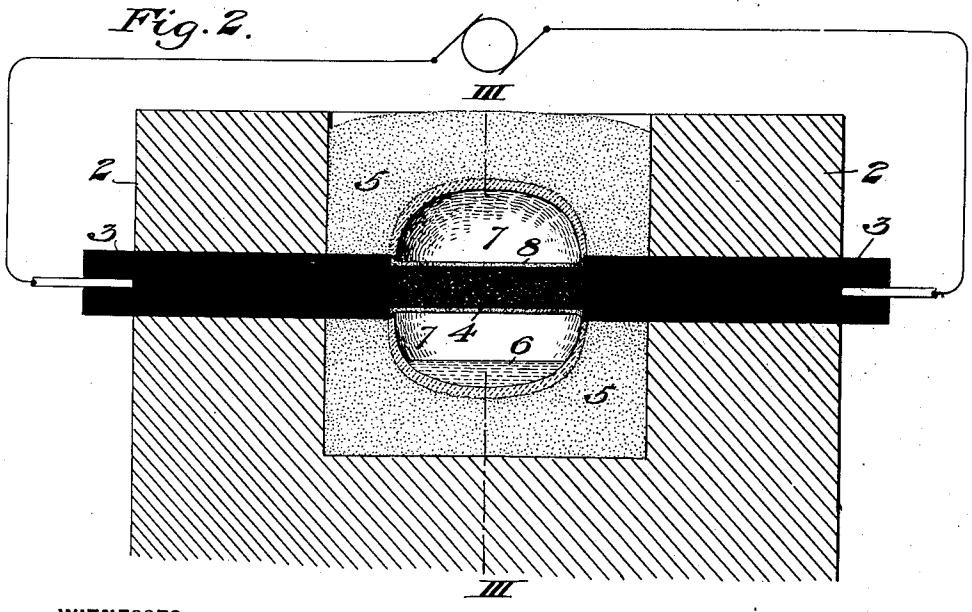


Fig. 2.



WITNESSES

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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

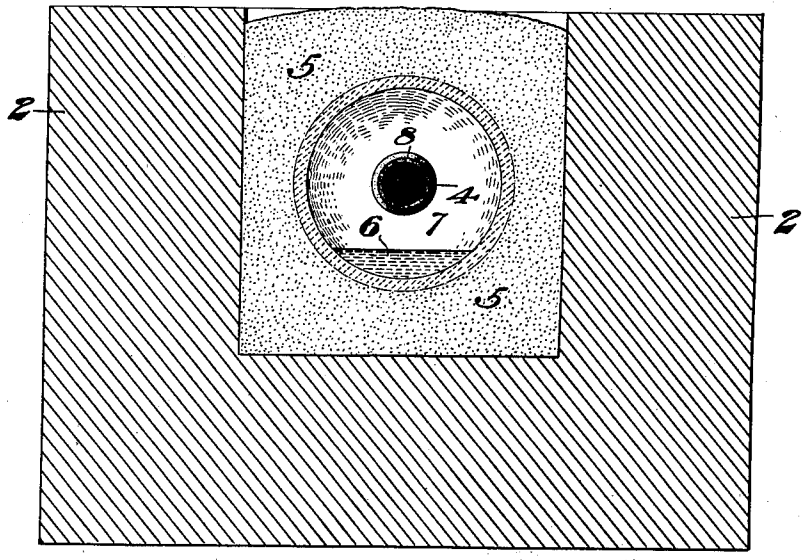
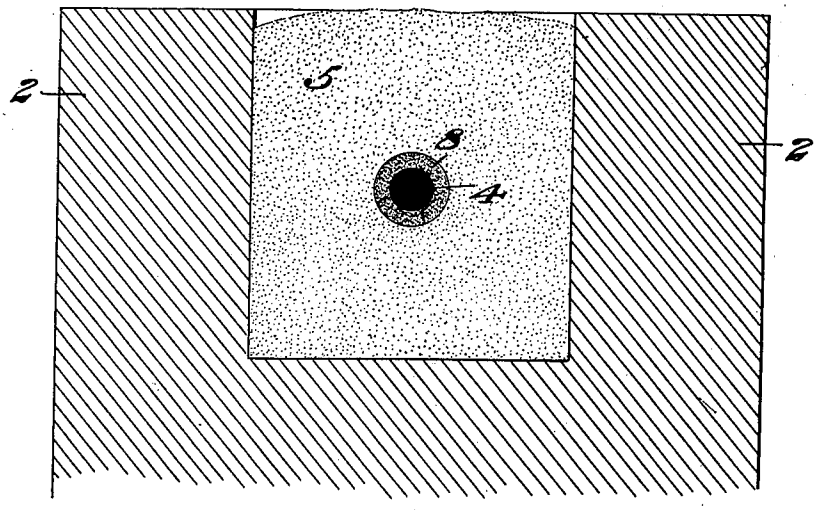


Fig. 4.



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EDWARD GOODRICH ACHESON, OF NIAGARA FALLS, NEW YORK.

METHOD OF REDUCING METALLIC OXIDS.

SPECIFICATION forming part of Letters Patent No. 718,891, dated January 20, 1903.

Application filed December 4, 1900. Serial No. 38,663. (No specimens.)

To all whom it may concern:

Be it known that I, EDWARD GOODRICH ACHESON, of Niagara Falls, in the county of Niagara and State of New York, have invented a new and useful Method of Reducing Compounds, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 shows in vertical longitudinal section an electric furnace prepared for the practice of my invention. Fig. 2 is a similar view showing the furnace at the end of the operation. Fig. 3 is a vertical cross-section on the line III III of Fig. 2. Fig. 4 is a vertical cross-section of a modified construction, showing the furnace before the beginning of the process.

My invention relates, primarily, to the reduction of metallic compounds under the influence of electrically-supplied heat. It makes it possible in an incandescent electric furnace to reduce such refractory compounds as alumina, silica, lime, &c., with the aid of carbon, so as to obtain an elementary product which is not a carbid and need not be in alloy with other metal.

I inclose a conducting-core of carbon in a protecting-sheath of a refractory carbid, which is either performed and placed around the conductor or is created in the furnace during the process, and having thus protected the conductor from contact with the material to be treated I heat such material by radiation from the conductor and cause the desired reactions to take place. The material to be treated consists of a mixture of the metallic oxid with a reducing agent, preferably carbon, and being shielded from the conductor is not affected chemically thereby to any injurious extent.

In the manufacture of substances such as silicon or boron, which form refractory carbids, I proceed as follows: When the carbid sheath is to be formed during operation, I place in the furnace a conductor composed either of granules of carbon or of carbon rods and surround it with the material to be treated, which consists of the sand or other refractory oxid mixed with carbon in about the proper proportions chemically to reduce it to elemental form. Where the conductor is is made of granular carbon and the sheath or shield is to be formed of the charge mixture, the effect of passing a current of electricity through the conductor is to raise it to an intense heat and to cause the charge mixture immediately adjacent to it to combine with it, so as to form a layer of carbid of silicon, (when sand is used in the charge,) which incloses the conductor like a sheath. This sheath or shield of carbid being refractory remains during the process and protects the carbon of the conductor from contact with the remainder of the material to be treated. The heat being transmitted through the shield raises the charge mixture to a high temperature. The carbon of the charge mixture then reacts upon the oxid, reducing it to elemental form and to a state of fusion, causing it to sink to the bottom of the cavity which is created in the charge mixture by the reduction. If the carbon conductor were not protected throughout the process by the carbid, it would combine chemically with or contaminate the reduced material.

Where the conductor for the current is not composed of granular carbon or where it is not desirable that the carbon core should be wasted in the formation of the carbid shield, I may place around the conductor in contact therewith a layer of the oxid to be treated, (or the oxid of any metal whose carbid is refractory,) mixed with carbon in sufficient proportion to combine therewith in the form of a carbid. The first heating action of the current is thus expended in converting this layer into a protecting-shield of refractory carbid, which protects the core, as above explained.

In the drawings, Fig. 1, 2 represents the walls of an electric furnace. 3 3 are the terminals of the dynamo-circuit. 4 is the conducting-core of carbon, which connects the terminals and is or may be constituted of granular coke, though rods or plates of carbon may be employed. 5 is the body of charge mixture which surrounds the conducting-core and is composed of the oxid to be reduced, mixed with powdered carbon or other suitable reducing agent in the well-known chemical proportion suitable for reduction.

Fig. 2 shows the furnace as it is at the end of the operation, 6 representing the body of

silicon or other reduced material which collects in a molten mass at the bottom of the cavity 7, which the reduction creates, and 8 represents the layer of carbid which constitutes the shield for the conductor and is of different nature from the conductor and from the charge to be heated and which is rendered sufficiently strong and dense during the process to uphold the conductor in place, even if the latter is made of granular carbon. At the end of the operation the reduced material having cooled into an aggregated crystalline mass is removed from the furnace for use.

When the material to be reduced is alumina or other material whose metal does not form a refractory carbid, I prefer to place around the conductor either a layer of carbon mixed with the oxid of a substance such as silicon, boron, &c., whose carbid is refractory, or I may preform the protecting-sheath by surrounding the core with a layer of previously-formed refractory carbid, (for example, carbid of silicon or carbid of boron,) preferably crushed to a finely-comminuted state, and I place the charge mixture around it. Where alumina is to be reduced, I mix alumina with carbon in about the proportions required chemically for its reduction to metallic form. In Fig. 4 I show a layer 8 of carbid placed around the conductor when the furnace is charged. When the current is passed through the conductor surrounded by crushed carbid, the heat created thereby recrystallizes and cements the layer 8 into a dense coherent tubular sheath, through which the heat is transmitted to the charge mixture, and the desired reactions take place in the manner above explained. The metallic aluminium when reduced will collect at the bottom of the cavity 7, from which it may be taken either by tapping or by removing it as a pig at the end of the operation.

The electric current which I employ may be alternating or direct and of a current density of, say, thirty amperes or more per square inch of cross-section of conductor when the conductor is granular and of greater current density when the conductor is made of rods or plates. Care should be taken not to use a current density great enough to generate such a high degree of heat as to decompose the carbid shield.

The incandescent furnace is in many respects the most efficient, easily-handled, and all-round useful design for electric heating; but it has heretofore been seriously limited by the reactions that take place between the conducting-core and the materials being operated upon. Efforts have been made to overcome this difficulty by interposing protecting-coatings, and for this purpose clay, corundum, and other highly-refractory materials have been used and found more or less efficient where the temperatures were not sufficient to cause the melting of the material of which they were formed or, as sometimes occurs, their reduction where they are in contact with the carbon conducting-core. Another difficulty that inventors have sought to overcome is the tendency of the current to leave the properly-prepared conducting-core and pass through the materials being operated upon where they form more or less of a conducting mass. To correct this difficulty, various materials have been suggested—such as clays, oxids, and in some instances finely-powdered carbon or charcoal on account of their relatively high resistance quality—as is suggested by Elihu Thomson in his Patent No. 513,602. All of these attempts have been more or less successful, but have not met the conditions as met by my discovery, that carbid of silicon might be used for the double purpose of preventing chemical reaction between the carbon core and the charge of the furnace and also largely assist in insulating the surrounding charge in order that the current might be more thoroughly confined to the prepared conducting-core. Carbid of silicon is stable at the highest temperatures ordinarily desired for metallurgical operations, and the silicon being already thoroughly satisfied no reaction occurs between it and the conducting-core. I have also discovered that it is inert at high temperatures while in contact with many materials it is desired to reduce, melt, or smelt in the electric furnace.

Within the scope of my invention as defined in the claims the process may be modified to suit the conditions of the particular material treated thereby, since

What I claim is—

1. The method of reducing metallic compounds, which consists in passing an electric current through an electrical conductor placed in proximity to the compound to be treated and shielded therefrom by a body of refractory carbid; substantially as described.

2. The method of reducing metallic oxids which consists in passing an electric current through an electrical conductor placed in proximity to the oxid to be treated, together with carbon in proper proportion to reduce the oxid to its elemental state, and shielded therefrom by a body of carbid, substantially as described.

3. The method of reducing metallic oxids, which consists in placing in proximity to an electric conductor the oxid to be treated mixed with a reducing agent in proper proportion to reduce the oxid to its elemental state, placing between the conductor and such mixture a layer of preformed refractory carbid, and passing an electric current through the conductor; substantially as described.

In testimony whereof I have hereunto set my hand.

EDWARD GOODRICH ACHESON.

Witnesses:
JOHN MILLER,
L. M. REDMAN.