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C. O. FAIRCHILD ET AL

APPARATUS AND PROCESS FOR FUSING MATERIALS

Filed April 19, 1924

Fig. 5.

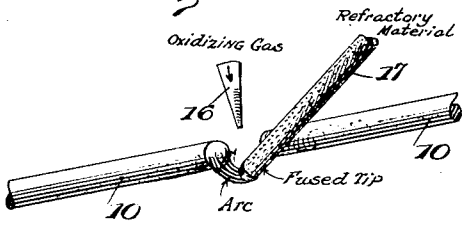


Fig. 4.

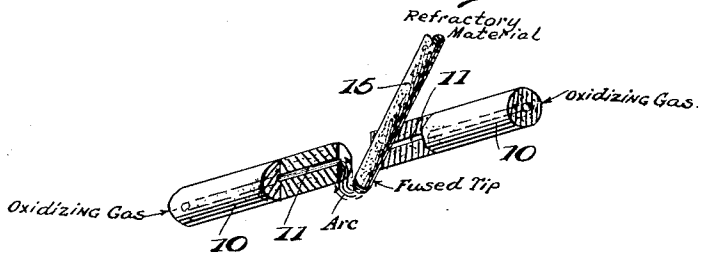


Fig. 3.

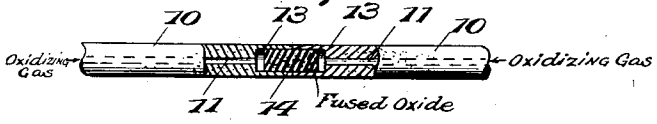


Fig. 1.

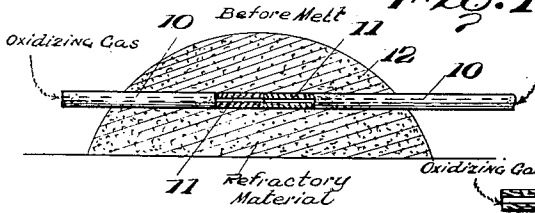
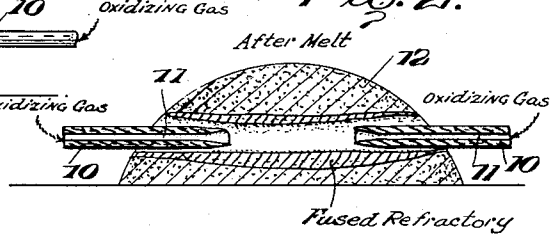


Fig. 2.



WITNESSES

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UNITED STATES PATENT OFFICE.

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APPARATUS AND PROCESS FOR FUSING MATERIALS.

Application filed April 19, 1924. Serial No. 707,673.

To all whom it may concern:

Be it known that we, CHARLES O. FAIRCHILD and MELVILLE F. PETERS, citizens of the United States, residing in Washington, District of Columbia, have invented new and useful Improvements in Apparatus and Processes for Fusing Materials, of which the following is a specification.

This invention relates to a process and apparatus for fusing materials.

The purpose of the present invention is to provide a process and apparatus whereby highly refractory materials such as thorium oxide, zirconium oxide, or the like, may be fused or melted in a practicable and efficient manner.

Other objects will hereinafter appear.

It is well known that thorium oxide, zirconium oxide and similar refractory substances are readily carbonized when heated to their melting points in contact with carbon or its vapors. It has heretofore been considered impossible to fuse the two oxides mentioned in a practicable manner or in appreciable quantities. The melting points of these oxides are exceeded only by those of tungsten and carbon, and on this account the electric arc or a similar heating agency must be used to obtain the necessary temperature for fusing these substances. In order to obviate the forming of carbides during the fusing or melting period, it is necessary to obtain the temperature of the arc in an oxidizing atmosphere. In the present invention an oxidizing gas is forced into the electric arc and thus maintaining the melting zone in an oxidizing condition.

It should be here pointed out that to prevent the formation of carbides when fusing or melting the oxides above referred to, a sufficient quantity of the oxidizing gas must be supplied to overbalance the tendency toward the formation of carbides, and by means of an excess of oxygen to force the reaction to an oxidizing one.

Different forms of apparatus for practicing the present invention are illustrated by way of example in the accompanying drawings, in which—

Figure 1 is a fragmentary view in side elevation illustrating the preferred arrangement of electrodes and material for carrying out a fusing operation in accordance with the present invention.

Figure 2 is a similar view, but showing portions of the material broken away and in section, whereby to illustrate the electrodes and refractory material after a fusing or melting operation.

Figures 3, 4 and 5 are schematic views showing other forms of apparatus for practicing the invention.

Like reference numerals refer to different parts throughout the several views of the drawings.

In each form of apparatus shown there is preferably employed a pair of electrodes 10. The electrodes may be of graphite similar in quality to that employed in electrodes used in connection with electric furnaces for smelting ores. In Figures 1, 2, 3 and 4 each electrode is provided with a central longitudinally extending bore 11, while the electrodes shown in Figure 5 are solid.

The form of apparatus shown in Figures 1 and 2 is preferably employed in practicing the present invention. In these figures it will be noted that the electrodes 10 are embedded in a pile of granulated or powdered material 12. The material may be either thorium oxide, zirconium oxide, or other highly refractory substance which it is desired to fuse. Preferably the material should be pulverized to permit packing thereof about the electrodes 10. It is, of course, to be understood that pulverizing the material is not entirely essential. The electrodes 10 may be connected to a suitable source of current supply in any conventional manner. It has been found that alternating current of the proper voltage will serve the purpose of fusing or melting these substances. Any suitable means can be employed for connecting the bore 11 of each electrode 10 with a source of oxidizing gas under pressure. The electrodes are preferably arranged, as shown in Figure 1, and embedded in the pulverized material 12.

In carrying out a fusing or melting operation an electric current is established through the electrodes 10, and also at this time the oxidizing gas is permitted to escape into the mass of material through the bores 11. The opposing ends of the electrodes are drawn apart whereby to strike an electric arc therebetween. The oxidizing gas partly escapes through the material. It should be here noted that this mass of material has a two-fold purpose, namely: first, that of stopping excessive loss of heat by

radiation; and secondly, that of forming a container for molten material as illustrated to advantage in Figure 2.

Upon the arc being struck between the electrodes, melting begins and the refractory oxide shrinks away from the arc forming a hollow enclosure, which assumes a cylindrical shape as the melting proceeds. The upper and side walls of this chamber melt and run to the bottom thereof, forming a pool which is exposed to the arc and the oxidizing atmosphere.

The tremendous temperature attained makes the molten mass highly conductive to an electric current, and it is quite probable that most of the current goes through the material surrounding the electrodes. During an operation the electrodes should be slowly moved toward each other in order to maintain the electrical resistance sufficiently low to pass the necessary current. The electrodes are consumed slowly, and, if desired, suitable mechanical means might be employed for gradually feeding the same toward each other. Melting of the refractory material retards the escape of gases and forces some of the oxidizing gas to escape around the electrode, thus consuming the outer walls of these electrodes as well as the inner walls thereof, as illustrated to advantage in Figure 2.

Melting may be continued until a pool is formed as large as can be safely held in the cooler outer portions of the pile of material. At this period the electrodes can be allowed to burn away until the inner ends thereof are disposed outside of the pile of material, when an arc will be established between each electrode and the pile of material. The entire current is now flowing through the molten material. The flow of electric current between the electrodes should now be stopped, and after a short interval the flow of oxygen or oxidizing agent should be stopped. The purpose of permitting the flow of the oxidizing gas after the stoppage of electric current is to insure the oxidation or consumption of any particles of carbon or small areas of carbide which may have formed, because the same were not fully exposed to the oxidizing gas. It is not at all times entirely necessary to permit the oxidizing gas to flow into the material after the electric arc has been stopped, viz, carbon and carbides may not exist after a melting operation. However, this is done as a precaution against the formation of carbide.

After the melted material is cooled, which is hastened by removing the layers of unfused material adhering thereto, the inner solidified mass may be removed and then any particles of partly fused or sintered material thereon may be knocked or scraped off. The fused material is often tubular in form and generally the top and side walls, relative to its position after solidifying, are extremely thin. By breaking away the upper and side walls of the tubular formation, an elongated dished shaped mass is obtained which is thick and constitutes perfectly fused oxide.

Thorium oxide, when fused and cooled, forms a clear glass or crystalline solid. Our product has a slight pink tinge which may be the natural color, or it may be that this color is given to the product by a slight amount of impurities in the substance. The fused material is very heavy, not very hard, and can be crushed and ground without difficulty. By this process of fusing we have been able to procure very pure thorium oxide.

The zirconium oxide, when fused, yields a product which is heavy, hard and opaque, with a light brown color or tinge. It is also found that this zirconium oxide is less pure in quality when compared with fused thorium oxide.

Referring to Figure 3, it will be noted that the bore 11 in each electrode 10 terminates at its inner end in an enlargement or recess 13. With the electrodes arranged as shown in this figure, the recesses 13 are adapted to accommodate a cylindrical body of refractory oxide, as indicated at 14. With this form of electrodes the material to be fused is entirely enclosed. The starting of the melting operation is made with the electrodes touching, i. e., the current is caused to flow through these electrodes when the same are in contacting relation, and in this way, using the electrodes as ordinary resistors. After slowly heating the refractory substance by the flow of electric current, the said current may be increased and then the electrodes pulled apart to strike an arc. The oxidizing gas is introduced through the hollow electrodes and the refractory material will melt rapidly. The molten oxide will drip from the recesses 13 of the electrodes. It has been found possible to melt a refractory material without striking the arc—thus using the electrodes as a resistance furnace. However, the use of the arc is found to be preferable.

Referring to Figure 4, the refractory material to be fused may be in the form of a bar or stick, as indicated at 15, and the oxidizing gas introduced through hollow electrodes, as in Figures 1, 2 and 3.

In Figure 5 a nozzle 16 is employed to project the oxidizing gas transversely to an arc between the electrodes 10. A stick or bar of refractory material 17 may be arranged between the electrodes 10, as shown. It has been found that fusing of the material can be had with either form of apparatus shown in Figures 3 and 4. However, the material can not be rapidly fused, and, consequently, the apparatus shown in

Figures 1 and 2 has been found preferable. In the form of apparatus shown in Figure 5, the stream of oxidizing gas has a tendency to blow out the electric arc established between electrodes 10. This is overcome by introducing the oxidizing gas through the hollow electrodes, as shown in Figure 4. In both forms of apparatus shown in Figures 4 and 5 the stick or bar of refractory material 15 and 17, respectively, will crack during a melting operation, which is undesirable. This disadvantage was overcome by the apparatus shown in Figures 1 and 2, and also by apparatus shown in Figure 3.

It is believed that the product, which may be obtainable in quantities by the process heretofore described, is extremely useful. It has been found that the coefficient of expansion of the fused material is less than that of unfused material—that is, assuming that the unfused material is thorium oxide. It has also been found that this material, when fused, has a higher thermal conductivity than previous to the fusing thereof, and that the fused material will stand thermal shock better than unfused material. Furthermore, fused thorium oxide is relatively free of impurities and will resist abrasion or corrosion to a greater extent than the unfused material. Crucibles have been made from the fused thorium oxide and it was found that the substance could be heated nearly to its melting point with practically no shrinkage, which is of apparent value.

While we have shown the preferred form of our invention and also other forms by which the same may be practiced, it is to be understood that we are aware of the fact that slight changes can be made by those skilled in the art for accomplishing our process without departing from the spirit of our invention, as indicated by the appended claims.

We claim:

1. The process of fusing or melting a refractory substance which consists in subjecting the substance to an electric arc in the presence of an excessive oxidizing agent.

2. The process of fusing or melting a refractory substance which consists in subjecting the substance to an electric arc in the presence of an excess of oxygen.

3. The process of fusing a refractory substance which consists in subjecting the substance to an electric arc and maintaining the atmosphere of the arc oxidizing.

4. The process of fusing a refractory substance which consists in embedding electrodes in a mass of the substance, striking an arc between the electrodes and introducing an oxidizing agent into the mass.

5. The process of fusing a refractory substance which consists in subjecting the substance to an electric arc and introducing an oxidizing agent into the arc.

6. The process of fusing a refractory substance which consists in embedding electrodes in a mass of the substance, striking an arc between the electrodes and introducing an oxidizing agent into the arc.

7. A method of fusing a refractory oxide, which comprises subjecting the oxide to a carbon arc in an atmosphere which will prevent the formation of the carbide.

8. In an apparatus for fusing refractory materials, a pair of electrodes arranged in end opposing relation and each opposing and having a cavity or recess to accommodate a refractory material to be fused by an arc established between said opposing ends.

9. In an apparatus for fusing refractory materials, a pair of electrodes arranged in end opposing relation and each opposing end having a cavity or recess to accommodate a refractory material to be fused by an arc established between said opposing ends, and each electrode having a longitudinally extending bore communicating with its associated recess or cavity to permit the introduction of a gas into said cavities.

10. In an apparatus for fusing refractory materials, a pair of electrodes arranged in end opposing relation, each opposing end having a cavity or recess, and said cavities being in registration to permit a refractory material to be supported between said electrodes and fused by an arc established between the opposing ends of said electrodes.

11. An apparatus for fusing refractory materials comprising a pair of electrodes arranged in end opposing relation to permit an arc to be established therebetween for fusing a refractory material disposed within the arc, and each electrode being provided with a longitudinally-extending bore to permit oxygen to be introduced into the arc from each electrode and obtain a uniform consumption of said electrodes.

12. A process of fusing refractory materials without forming the carbide thereof, which comprises maintaining an excessive oxidizing atmosphere during the fusing period of said material.

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