P. M. HULBERT.

PROCESS OF MANUFACTURING ARTICLES OUT OF HIGHLY REFRACTORY MATERIAL.

APPLICATION FILED SEPT. 24, 1906.

1,155,358. Patented Oct. 5, 1915.

Fig. 1

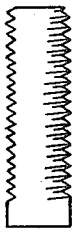


Fig. 2

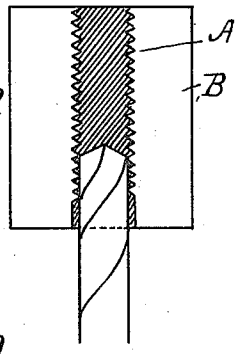


Fig. 3

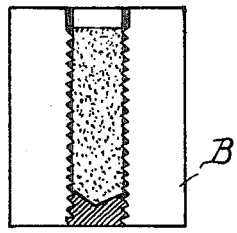


Fig. 4

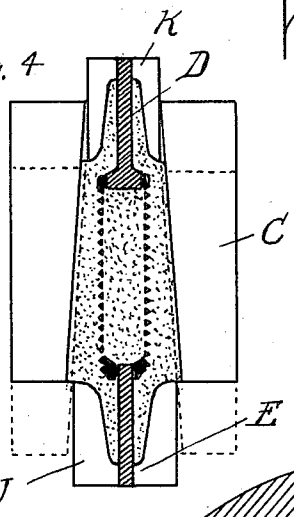


Fig. 6

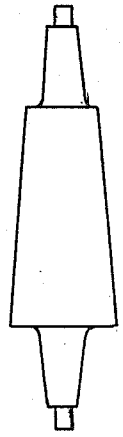
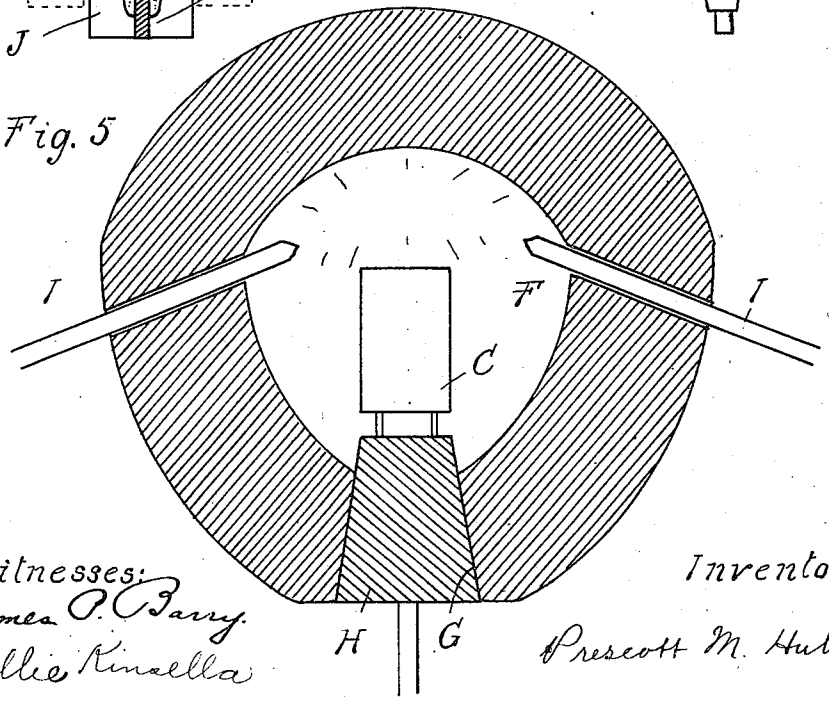


Fig. 5



Witnesses:
James A. Barry.
Nellie Kinsella

Inventor
Prescott M. Hulbert

UNITED STATES PATENT OFFICE.

PRESCOTT M. HULBERT, OF DETROIT, MICHIGAN.

PROCESS OF MANUFACTURING ARTICLES OUT OF HIGHLY-REFRACTORY MATERIAL.

1,155,358. Specification of Letters Patent. Patented Oct. 5, 1915.

Application filed September 24, 1906. Serial No. 336,048.

To all whom it may concern:

Be it known that I, PRESCOTT M. HULBERT, a citizen of the United States of America, residing at e city of Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Processes of Manufacturing Articles Out of Highly-Refractory Material, of which the following is a specification, reference being had therein to the accompanying drawings.

The invention relates to the manufacture of articles of highly refractory materials, such, for instance as silica, alumina, magnesia and other metallic oxids.

The invention consists in the novel method of integrating the material and of fashioning the same to the form desired, as hereinafter set forth.

The drawings illustrate a specific application of the method, namely, the manufacture of a protected electrical heating unit.

Figures 1 to 5 illustrate the successive steps in the manufacture, and Fig. 6 the manufactured article.

Broadly described, the method includes the following steps, first the molding of the desired shape from the finely comminuted refractory material; second, the heating of the molded article to a temperature at which integration takes place. This method differs from the usual methods of manufacturing pottery and porcelain wares first, in that no binding material is necessarily employed. The form is given and is retained throughout the process by the shape of the mold. Furthermore, the material may be homogeneous and the particles are brought together solely by pressure without the necessity of moistening. My improved process is further characterized by the method employed in baking or effecting the final integration of the material. This involves the heating of the mass to a temperature approximating the fusing point of the material employed whereby the particles are softened, and caused to adhere to each other without a binding substance. The integration may be carried to any degree desired from a point where a soft crumbling body is obtained to the point where the whole mass is practically fused.

In the specific embodiment of my invention illustrated in the drawings, electrical heating units are formed by incasing an oxidizable conductor, such as carbon, with a non-oxidizable refractory material, such as silica. Thus, the carbon which forms the heating resistance, and in operation is raised to a high temperature, is inclosed and hermetically sealed, while the protecting body forms a medium for conducting the heat from the resistances and distributes it to the point desired.

In order to secure a comparatively high resistance in a unit of small dimensions, I preferably form the carbon conductor of spiral shape. I also preferably employ graphitic carbon, and preferably the artificially prepared graphite, for the reason, first, that I have found this substance capable of being cut into spirals having a small section of considerable length, and, second, for the reason that the graphite having been subjected to an extremely high temperature during the process of its manufacture will not change in form or composition by any subsequent heating to which it may be subjected.

As illustrated, Fig. 1 represents a rod, of artificial graphite, which has been threaded for a portion of its length. This threading operation may be performed by any of the usual methods employed in threading metals. Fig. 2 represents the second step in the manufacture, in which the threaded rod A is inclosed in a sectional case, or jig, B closely fitting the threads and holding the work to be further operated upon. The next operation also illustrated in Fig. 2 is the boring or cutting away of the center of the rod, so as to intersect the threads, and sever the same to form a spiral. The third step in the operation is the filling of the cavity formed by boring with the refractory material, such as the finely comminuted silica. This may be done while the graphite spiral is still retained in the jig, and sufficient pressure is applied to compact the mass. In the next step of the process, the spiral removed from the jig is placed within a mold C, preferably formed of graphite, and is surrounded by a mass of the refrac-

tory material. This is suitably compacted by pressure or tamping, and surrounds the spiral as well as the terminals connected therewith. These terminals may be formed by separate rods of graphite D and E mechanically fitting the ends of the spiral A, and extending oppositely outward therefrom. The mold is also fashioned that the silica covering will also surround these terminals and extend to near the ends thereof.

The final step of the process is the heating of the molds to the required temperature, this temperature being approximately the fusing point of the refractory material and consequently very high. As it is practically impossible to obtain the required heat by combustion, I preferably employ an electric furnace, such for instance as illustrated in Fig. 5, in which F is the furnace chamber formed within walls of more highly refractory material than the substance operated upon, for instance, a magnesium oxid lined furnace may be employed in the manufacture of the ware from silica. The opening into the furnace chamber is preferably formed in the bottom, as at G, and the work is introduced by suitable means, such as by supporting it upon a vertically removable plug H. The cavity is heated by an arc sprung between carbon electrodes I introduced through the sides and near the upper portion of the chamber F. This will develop within the chamber a very high temperature, and the heat is distributed by reflection from the walls, so as to uniformly heat the mold C when placed therein. This mold being formed preferably of graphite will not itself be changed by heat.

After heating for the required length of time, the mold is withdrawn from the furnace, and the article removed therefrom. The effect from the heating is to thoroughly integrate the silica, so that the graphite spiral is hermetically sealed and is thoroughly protected from oxidation. To complete the resistance, the ends of the graphite terminals D and E are provided with suitable connections by which they may be included in an electric circuit. An electric current may then be passed through the spiral, and the heating effect may be carried to any extent desired below the fusing point of the silica case, which latter is higher than the temperature required in most of the arts.

While I have described one specific embodiment of my invention, it is obvious that it is applicable to many other uses.

As shrinkage will take place during the integration process, I preferably employ contractible molds. As illustrated, the cavity within the mold C is tapered toward the top, and the bottom J of the mold is separate from the portion C, and supports the latter through the medium of the material within the cavity. Thus, as contraction takes place, the mold C will slip downward, so that a portion of less diameter will inclose the material. The top K of the mold is also preferably formed of a separate piece, which may lower to compensate for any contraction. This mold is preferably formed by fashioning the same from a solid block of artifically prepared graphite. The nature of this substance is such that it may be easily cut, and at the same time it possesses a considerable degree of rigidity, so that when once formed it will retain its shape. Moreover, this shape will not be changed even where heated to an excessively high temperature.

The refractory material, which is employed, is preferably finely comminuted. Thus it will take the form of the finest detail in the mold and during the integration process will shrink less than where coarser material is used.

What I claim as my invention is:

1. The method of forming articles of highly refractory materials which consists in compacting the comminuted material in a mold corresponding to the final form of the article, said mold being formed of a more highly refractory material and one which will not combine with the contained material at the temperature to which it is subjected, in then heating the mold to produce integration by surface adhesion of the particles of the contained material.

2. The method of forming articles of highly refractory materials which consists in compacting the comminuted material in a carbon mold corresponding to the final form of the article and heating said mold to produce integration by surface adhesion of the particles of the contained material.

3. The method of forming articles of highly refractory materials which consists in compacting the comminuted material in a fashioned mold of graphitic carbon corresponding to the final form of the article and in heating the mold to produce integration by surface adhesion of the particles of the contained body.

4. The method of protecting high fusing oxidizable electrical heating resistances which consists in embedding said resistance in a body of comminuted non-oxidizable refractory material with enlarged terminals leading out from said body and in heating the body to integrate said refractory material and hermetically seal and protect from oxidation the resistance therein.

5. The method of protecting carbon heating resistances which consists in embedding and completely protecting the same in a body of comminuted non-oxidizable refractory material and in heating to produce integration of said refractory material.

6. The method of forming electrical heating units which consists in embedding a

graphite helix in a body of comminuted refractory material, and in heating to produce integration of said material and the sealing therein of said helix.

7. The method of forming electrical heating units which consists in embedding a tortuously extending resistor of graphite in a body of comminuted refractory material and in heating to produce integration of said material and the sealing in of said resistor.

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

PRESCOTT M. HULBERT.

Witnesses:
JAMES P. BARRY,
NELLIE KINSELLA.