April 29, 1930. M. FOURMENT 1,756,457

MANUFACTURE OF OBJECTS CONSISTING OF REFRACTORY, INSULATING, ABRASIVE, OR LIKE SUBSTANCES

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Fig_1

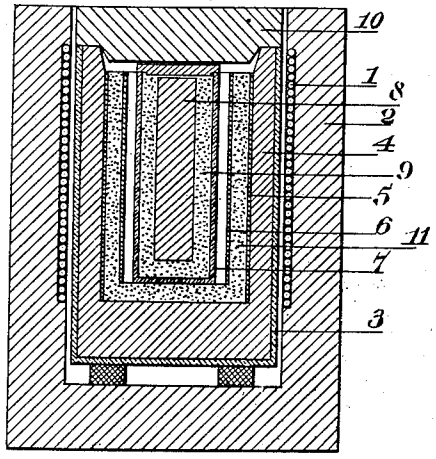


Fig_2

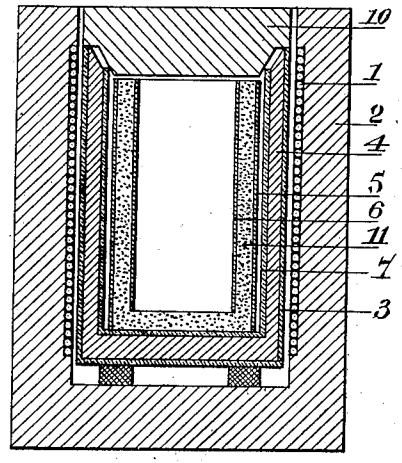
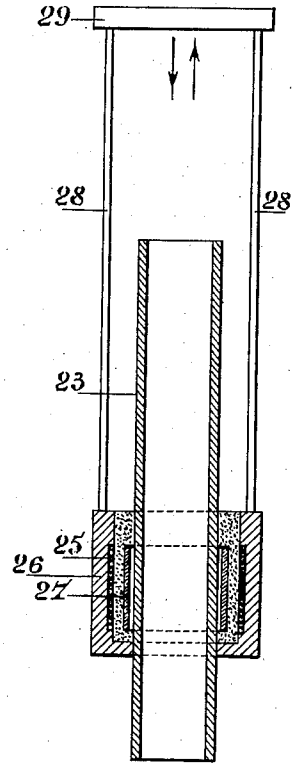


Fig_5



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Fig. 3

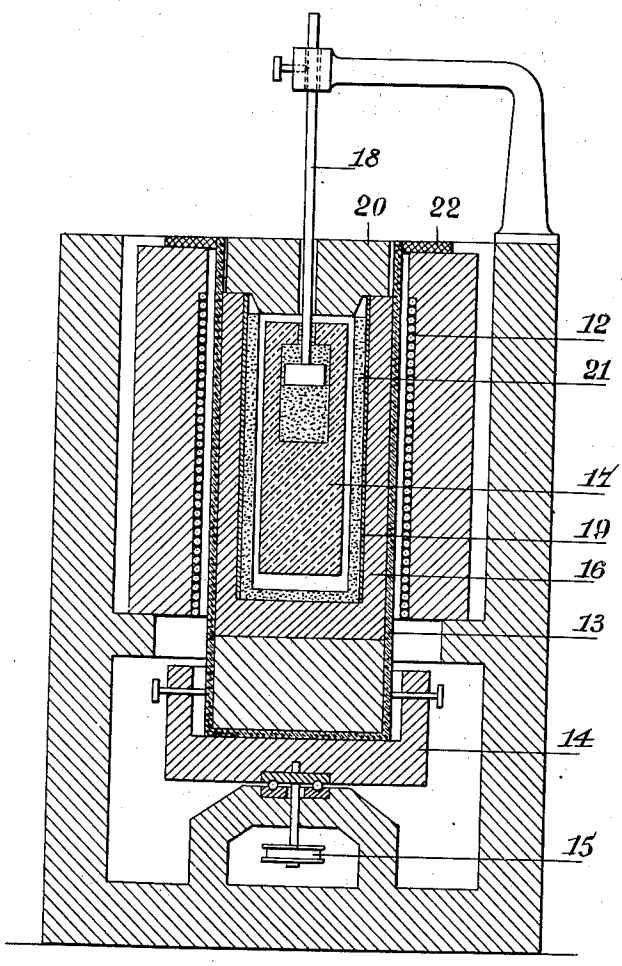
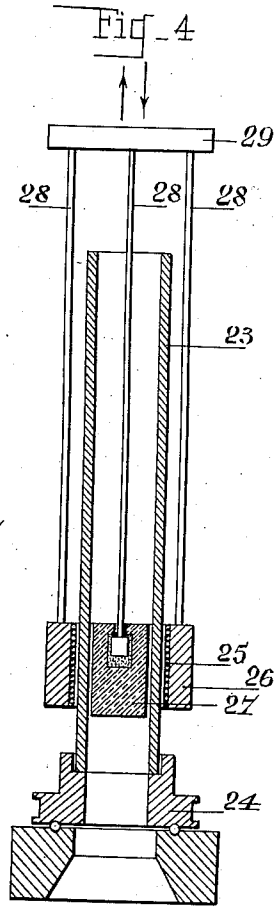


Fig. 4



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UNITED STATES PATENT OFFICE

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MANUFACTURE OF OBJECTS CONSISTING OF REFRACTORY, INSULATING, ABRASIVE, OR LIKE SUBSTANCES

Application filed December 13, 1927, Serial No. 239,748, and in France December 21, 1926.

The present invention has for its object a process for the manufacture of objects consisting of refractory, insulating, abrasive or like substances, in which the objects are heated by the use of pieces of conducting material such as carbon, which are heated by induction currents of high frequency.

The invention further relates to apparatus by which the said process may be carried into effect.

According to the invention, such apparatus comprise a refractory envelope carrying a winding which is connected with a source of high frequency electric current. In the interior of the said envelope 1 dispose the object to be heated and also the piece or pieces of conducting material such as carbon, so that the heat produced by the said pieces will raise the object to the proper temperature.

It may be advantageous to render the said refractory envelope movable, as well as the said piece of conducting material, and in this case the conducting pieces are placed in the interior or at the exterior of the object to be heated, or both in the interior and at the exterior.

Various apparatus according to the present invention are shown by way of example in the appended drawings.

Fig. 1 is a vertical section of the first apparatus, in which the tube is stationary and the heating is effected by means of a carbon cylinder which is placed in the interior of the hollow object to be manufactured.

Fig. 2 is a vertical section of a second apparatus in which the tube is stationary and the heating is effected by a carbon cylinder placed at the exterior of the hollow object.

Fig. 3 is a vertical section of a third apparatus in which the tube is rotated on its axis.

Figs. 4 and 5 are vertical sections of other forms of apparatus in which the relative positions of the tube and the induction winding are variable, for the internal and external heating of objects of great length.

The apparatus shown in Figs. 1 and 2, is adapted for the manufacture of a refractory crucible of cylindrical form; 1 is the inductor winding which may consist of a copper tube, optionally cooled by a current of water. The said winding is applied against the internal wall of a solid member 2 which may consist of cement or like material. The tube in which the refractory crucible is to be formed comprises an envelope 3 consisting of a suitable dielectric, such as fused silica, placed in contact with a second envelope 4 consisting of a refractory and heat-insulating substance. In the interior of the resulting double envelope are disposed two tubes 5 and 6 consisting of paper or pasteboard. The space 11 between the said tubes contains the refractory substance or mixture of which the said crucible is to be made. In the interior of the tubes 5 and 6, as shown in Fig. 1, or at the exterior of the said tubes, as shown in Fig. 2, is disposed a cylinder 7 of carbon or like substance.

In the device shown in Fig. 1 the cylinder 7 may be solid or hollow, and in this latter case it may contain a solid refractory member 8 which is surrounded by a heat-insulating substance 9. This combination is closed by a cover 10 of refractory material.

When a high frequency current flows through the winding 1, induction currents are produced at the periphery of the carbon cylinder 7 whereby it is brought to a high temperature, thus being theoretically unlimited. The pasteboard tubes 5 and 6 are thus carbonized, and the substance in the annular space 11 may be brought to the temperature which is required in order to obtain the desired crucible by the heating action. If the space 11 contains clay, bauxite, silica, alumina, or the like, these substances must be heated to their softening or melting point; if the said space contains mixtures of different substances adapted for mutual reaction, the mixture must be raised to the temperature at which this reaction will take place. This is the case in which the crucibles or like objects are to be made of sillimanite, and herein the space 11 is filled with a mixture of sand and alumina in suitable proportions; if the objects are to be made of carborundum, the said space contains a mixture of sand and powdered carbon; if made of zirconium car-

bide, the space contains a mixture of zirconium and powdered carbon, and so on. In other cases the mixture may consist of a refractory substance which forms the greater part of the crucible, to which is added a certain percentage, usually, small, of another body which is adapted to combine with the principal substance so as to bind its different particles together. For example, the principal substance may be zirconia, alumina, magnesia or the like, and the secondary substance may consist of silica, carbon or the like. If the principal substance is alumina, and the secondary substance silica, I obtain after heating the mixture to 1800 degrees a crucible consisting of grains of alumina which are bound together by silicate of alumina or sillimanite. Numerous examples in which the said process is carried into effect can thus be given.

Fig. 1 corresponds to the apparatus which is chiefly adapted for heating the interior of the crucible to be manufactured. Fig. 2 corresponds to the case which is chiefly adapted for heating the exterior of the crucible.

By the use of two carbon cylinders 7, comprising a thin cylinder at the exterior of the space 11, and a cylinder in the interior of the space 11, I may effect the simultaneous heating of the interior and the exterior of said crucible.

In the apparatus shown in Fig. 3 it is desired to manufacture a tube or like hollow object from powdered substances which have no mutual cohesion; 12 is the inductance winding which consists of a copper tube as in the example shown in Fig. 1. The tube 13 in which the object is to be formed is, in this example, capable of rotation, hence it is mounted on a disk 14 which is rotatable on a vertical or horizontal shaft by means of the actuating device 15. In the tube 13 is disposed a refractory and heat-insulating envelope 16. In the interior of the tube 13 and coaxial therewith is a cylindrical carbon (or graphite) block 17 which may be lowered and is adapted to be held in a fixed position; said block may be suspended by a rod 18 of silica or the like, and it may be suitably adjusted in height. In the space between said block and the tube 13 is placed the substance or the mixture adapted to form the hollow object, such as a tube, which is to be obtained. Under the effect of centrifugal force, the said substance is brought into contact with the internal wall of the envelope 16, and herein I employ a paper or pasteboard tube 19 which will be carbonized, so that the object can be readily removed. The tube 13 is closed by a plug 20, and is guided in a collar 22. When a high frequency current is sent into the winding 12, induced currents will be set up in the block 17 whereby its surface portion will be highly heated. I may thus heat or melt the powdered material placed in the space 21 between the block 17 and the envelope 16 of the rotatable tube 13. The action of centrifugal force upon the grains whereby they are pressed together will facilitate their agglomeration, by mutual chemical reaction or by softening, or will facilitate the disengagement of gas, or the like.

The refractory envelope 16 may be dispensed with, and in this case the substance to be heated will fill almost the whole of the annular space between the tube 13 and the block 17, and herein the agglomeration at high temperatures will take place only adjacent the block 17 and concentrically with the latter, upon a thickness which can be varied with the duration of the heating and the temperature of the block. If the object thus produced is not sufficiently baked upon its outer face, this latter can be brought to the proper temperature by placing the object for a certain time in another (carbon) crucible which is raised to a high temperature by induced currents of high frequency, according to the arrangement shown in Fig. 2.

If it is desired to obtain an object which is closed at the bottom, such as crucible, the rotation of the disk 14 is slowed or even stopped at the end of the operation, and the half-melted or entirely melted material will collect at the base in order to form the bottom part.

In the example shown in Figs. 4 and 5 it is desired to heat a hollow object which may have a great length, it being preliminarily mounted and agglomerated in the usual manner; 23 is the object to be heated, and it rests upon a disk 24 which may be stationary, or it may be rotated or given a vertical reciprocating motion. The inducing winding 25 is embedded in the internal wall of a block 26 of an imperfect heat-conducting substance; 27 is the carbon (graphite) cylinder which is brought to a very high temperature by induction by means of high frequency currents passing in the winding 25; the blocks 26—27 are suspended by means of the rods 28 to a cross bar 29, which allows of modifying the relative positions of the device thus formed and of the object to be heated. The object 23 can thus be gradually heated upon its entire height by raising or lowering the object 23 or the device suspended from the bar 29.

Fig. 4 shows the apparatus employed for heating the interior of the object and Fig. 5 shows the apparatus for heating the exterior.

For the heating of the internal wall (Fig. 4) the hollow object 23 to be heated may be supported by an outer mold consisting of a dielectric substance, optionally combustible. Such an arrangement is used when the paste forming the said object has but little consistency.

I may also proceed as shown in Figs. 1 and 2. The object 23 may be simultaneously heated by the use of a device comprising two

cylinders 27 whereof one is a thin cylinder placed at the exterior and the other is placed in the interior.

Having now described my invention and in what manner the same is to be performed, I declare that what I claim is:

1. In the art of making articles of a tubular shape, from comminuted dielectric material which is capable of being sintered by heat, the steps of including the comminuted material between concentric tubes of papery material, locating an inductance heating element in proximity to and parallel with such inclosed body of comminuted dielectric material, heating such heating element by induced currents to a sufficient temperature to sinter the comminuted material into a coherent body and thereby carbonizing such supporting tubes.

2. The process of baking objects of tubular form of a refractory and dielectric substance, by placing a piece of conducting heat resisting material capable of being heated to a high temperature by induced currents, in the interior of the tubular object to be baked, in leaving a space between said piece and the object to be baked, thereafter heating the piece by means of induced electric current to a temperature sufficient to bake the object.

3. In the manufacture of objects of tubular form starting with comminuted dielectric material capable of being sintered by heat, the process which consists in forming the comminuted material into a tubular shape, a tube of combustible material being interposed between the said material and the heating element, and in then heating the element by means of induced electric currents of high frequency to a temperature sufficient to sinter and agglomerate the comminuted material into a solid tubular body and in thus burning the tube of combustible material.

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