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ELECTRIC FURNACE

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Fig. 1

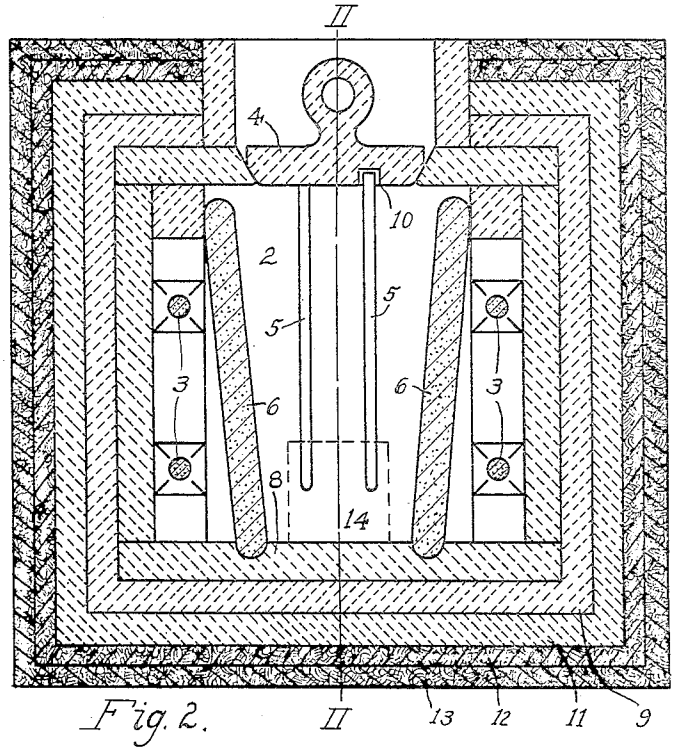
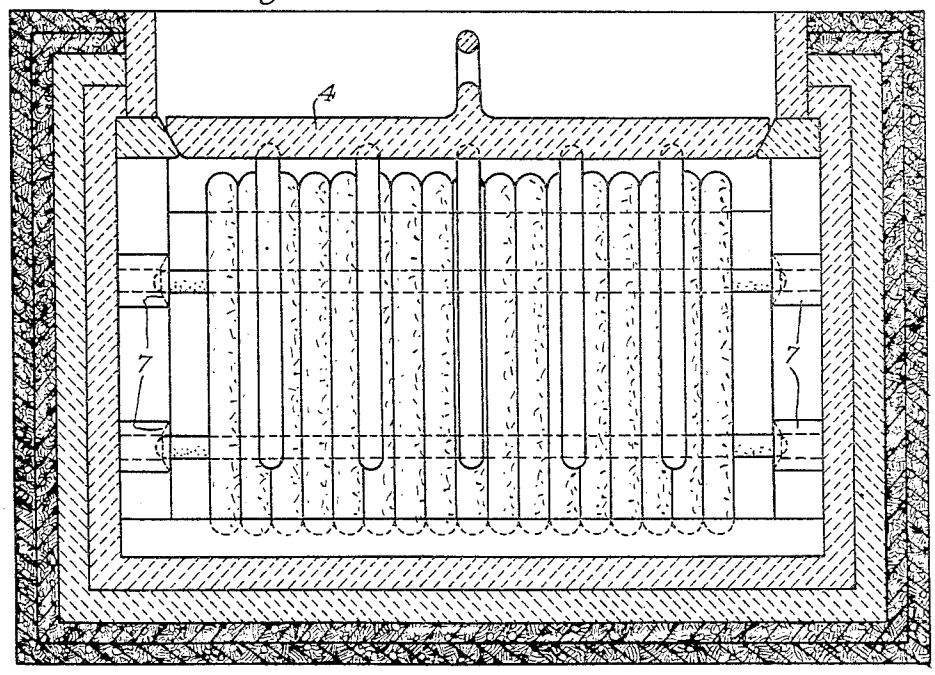


Fig. 2.



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ELECTRIC FURNACE

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6 Claims. (Cl. 13—20)

This invention relates to the manufacture of ceramic articles and particularly to the annealing of such articles and to the apparatus for carrying out the process.

The object of the invention is to provide a new and improved process for removing the irregularities, such as warping, produced during the prior steps in the manufacture of long slender ceramic articles and to provide new and improved apparatus for accomplishing this purpose. Other objects of the invention will become apparent from the following specification and claims.

Long, slender, ceramic articles, such as hollow insulators for thermocouple wires and thermometer tubes, should be straight and uniform in their finished state, but inasmuch as the methods employed heretofore have produced a great many warped and irregularly shaped articles it has been necessary to reject a large percentage of the articles made and to use only the ones that came through the process in a satisfactory condition. There has been no way of reclaiming articles that become distorted.

By our process we are enabled to reclaim the majority of articles that would be rejected as unsuitable if made according to the prior methods.

Some of the principal problems that we have solved are the shielding of the ceramic objects to be treated from direct radiation, and the support of the ceramic objects in such a manner that they may be inserted and removed from the furnace simultaneously without seriously affecting the temperature conditions of the furnace.

The furnace which we have designed to meet these conditions is illustrated by the accompanying drawing in which:

Figure 1 is a vertical section of the electric annealing furnace in a plane at right angles to the resistor rods used for heating the furnace; and

Figure 2 is a section on the line 2—2 of Figure 1.

Referring to the drawing in detail, a heating chamber 2 is provided with a plurality of rigid resistor rods 3 which consist mainly of silicon carbide. These resistor rods are mounted at the sides of the heating chamber which is permanently closed on all sides excepting a portion of the top wall where there is a removable cover piece 4. There may also be a small door near the base for the removal of débris from time to time. The cover piece 4 is used to support a large number of ceramic objects 5 which are held in holes 10 made in the lower portion of the cover. The furnace has a number of similar cover pieces 4. Cover pieces not in use on the furnace are loaded with a plurality of ceramic articles 5 by inserting and holding them in the holes provided for the purpose. The cover piece with its load is placed in such a manner as to bring the ceramic articles in the central portion of the heating chamber and close up the furnace as illustrated in the drawing. The ceramic articles hang in a position in which the action of gravity tends to straighten them out at high temperatures. The ceramic articles experience a gradual change in temperature on introduction to the furnace as they are shielded from direct radiation emitted by the resistor rods 3.

The shielding mechanism disclosed in the drawing consists of two banks of cylindrical rods or bars 6 which rest in a position inclined slightly to the vertical and so that they loosely contact with each other. These rods are preferably made of silicon carbide because rods of this material, when properly made, retain a large part of their mechanical strength even up to a dazzling white heat. This is particularly true of rods made of recrystallized silicon carbide. While some radiation penetrates between rods 6 it is so scattered by reflection from the tangential surfaces of the rods 6 that the articles 5 are not subjected to appreciable radiation from the resistor rods 3. This result follows also from the fact that the resistor rods 3 are at right angles to the screening rods 6.

The resistors 3 are made of recrystallized or bonded silicon carbide. They extend completely across the heating chamber, the end portions being supported in conical recesses 7 which extend slightly into the furnace wall. Mechanical support and electrical engagement are obtained by butt-end engagement with resiliently supported water-cooled terminals (not shown) such as are disclosed in the United States Patent to Shaw, No. 1,742,286, January 7, 1930.

The cover 4 and inner section of the furnace wall 8 are made of high temperature refractory, such as fused alumina bricks or silicon carbide bricks. The high temperature refractory section of the wall is surrounded by a wall section made of insulating bricks 9 composed of porous clay refractory such as is described in the United States patent to Hartmann, No. 1,545,559, patented July 14, 1925. The porous clay refractory section is surrounded by another insulating section 11 made, for example, of "Silo-cel" bricks. An outer section 12 of low temperature insulating material such as magnesia or asbestos can be provided to further reduce the heat losses. This material is contained within an outer casing 13.

On account of the large heat capacity of the

banks of massive rods 6 and the refractory walls 8 (as well as the extensive provisions for insulation) the furnace is very economical of power and efficient in operation.

Our furnace is especially adapted to the mass production of ceramic articles which require uniform heat treatment under conditions which favor the maintenance of a cylindrical or bar shape. Such objects may, for example, be thermometer tubes composed of pyrex or fused silica. Many other ceramic objects in the form of rods or bars may be subjected to heat treatments in extended lengths as shown in the drawing. After the heat treatment is completed, such extended bodies are cut into suitable lengths. In this way it is possible to manufacture short objects of regular shape and sightly appearance. These results would be difficult to obtain if these short objects were heat treated in short lengths.

The silicon carbide shields or baffles 6 have many advantages in addition to those already mentioned. They provide a larger radiating surface than would be provided by baffles composed of bricks or tiles. They also permit close temperature control of the objects 5 by reason of the good thermal conductivity of silicon carbide and its high emissivity. They also provide a more uniform distribution of the heat from the resistors and are readily replaced.

The furnace which we have described is especially easy to operate from the fact that when it is opened it throws the radiation which escapes on removal of the cover in an upward direction where it does not disturb workmen in the vicinity. The ceramic objects to be heat treated can therefore be inserted or removed with a minimum of inconvenience. Débris which falls from objects to be heat treated collects on the floor of the heating chamber and may be removed through a door 14 indicated in Figure 1.

The method which we have described may be applied to any kind of ceramic object which is intended to have a substantially uniform cross-section. Thermometer tubes and baked clay cylinders may be cited as examples. Clay bonded articles are vitrified previously to the straightening process. The straightening temperature is carried to the initial softening point of the glass or clay bond. Instead of glass or clay other bonding materials of simpler character may be used such as calcium fluoride or other alkaline earth halide, aluminum fluoride, etc. Binary mixtures may also be used as bonds, such as a mixture of lime, 25—35 per cent and titanium oxide, 65—75 per cent. Bonds of this character are particularly resistant to reducing atmospheres at temperatures in the neighbourhood of 1,300° C.

The advantages of our method of heat treatment of cylindrical ceramic objects are particularly obvious when this method is compared with the usual method of heat treatment of such objects while they are supported in a horizontal position in contact with horizontally disposed hearths. In the case of our method, on the contrary, the portions of the ceramic objects which are to be later used are supported in isolated positions where they are heated only by radiation and their sides are in contact with gaseous material only, thereby eliminating the liability of injury or disfigurement of the objects during insertion or removal.

We claim:

1. A furnace for the heat treatment of ceramic objects comprising a heating chamber, electrical heating resistors within said chamber, a removable cover from which objects to be heat treated are supported in vertically downward position by attachment of their upper ends to the cover, and a screen of refractory rods interposed between the electrical resistors and the ceramic objects under heat treatment.

2. A furnace for the heat treatment of ceramic objects comprising a heating chamber, electrical heating resistors within said heating chamber, a removable cover from the lower surface of which extend objects to be heat treated while secured to said cover to extend into vertically downward position in said heating chamber, a bank of refractory bars of high thermal conductivity and high emissivity placed between said resistors and the objects to be heat treated, a wall of high temperature refractory surrounding said heating chamber, and walls of insulating material surrounding said high temperature refractory.

3. A furnace for the heat treatment of ceramic objects comprising a heating chamber, electrical heating resistors horizontally disposed adjacent to side walls of said heating chamber, a removable cover of highly refractory material to which are attached ceramic objects to be heat treated in a vertical position in said heating chamber, a bank of refractory bars of high thermal conductivity and high emissivity placed between said resistors and the objects to be heat treated, a wall of high temperature refractory surrounding said heating chamber, and walls of insulating material surrounding said high temperature refractory.

4. In an electric furnace, a furnace chamber, a rod shaped resistor extending along a side wall of the said chamber, and a series of refractory rods of high thermal conductivity interposed between the resistor and the ware being treated in the furnace, the said rods being adapted to shield the ware from the direct radiation of the resistor and being positioned so that their principal axes are in a direction substantially at right angles to the principal axis of the resistor, the rods being adapted to receive heat from the resistor and reradiate it from an area substantially wider than the lateral area of the resistor.

5. In an electric furnace, a furnace chamber, a rod-shaped resistor extending horizontally along a side wall of the said chamber, and a series of refractory rods of substantially circular cross section adjoining each other and interposed between the resistor and the ware being treated in the furnace, the said rods being adapted to shield the ware from direct radiation from the resistor and being in an upright position so as to reradiate the heat from the resistor from an area substantially wider than the lateral area of the resistor.

6. The furnace described in claim 5, in which the rods shielding the ware from the resistor are composed of silicon carbide.

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