Aug. 24, 1937. R. REICHMANN 2,091,107

ELECTRIC HEATING ELEMENT AND METHOD OF MAKING THE SAME

Filed July 14, 1933

Fig. 1

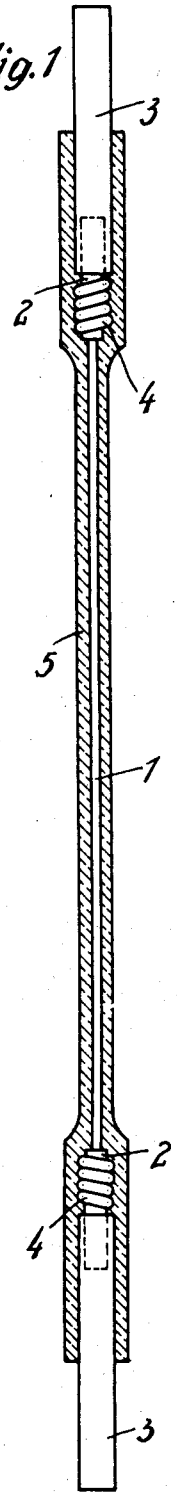


Fig. 2

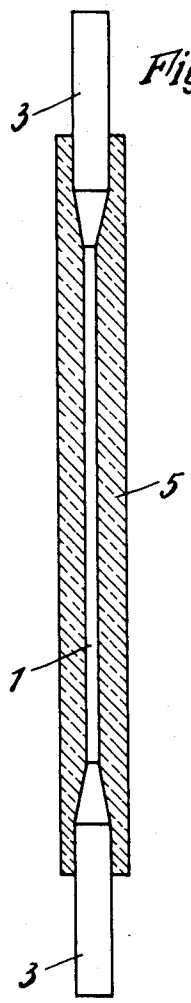
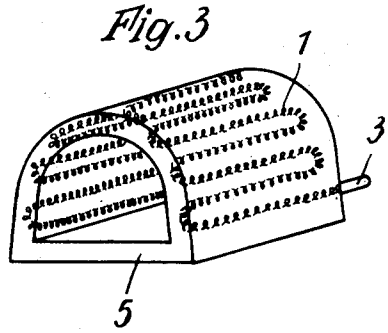


Fig. 3



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ELECTRIC HEATING ELEMENT AND METHOD OF MAKING THE SAME

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2 Claims. (Cl. 201—64)

My invention relates to electric heating elements and to a method of making the same. It has hitherto been possible to construct electric resistance furnaces for high temperatures which may be operated in a reliable manner only at temperatures up to 1100° C. without the use of any particular neutral gas. Even the highly refractory metals in contact with air oxidize very rapidly at a high temperature so that the resistor members which are, as a rule, thin are subjected to a rapid deterioration. It is true, that by the use of platinum as resistance material higher temperatures may be obtained than is the case with other materials. Platinum, however, has not come into extensive use owing to its prohibitive price and also because it has the tendency to volatilize at a high load and is, therefore, subject to recrystallization so that platinum as heating resistor has but a limited durability.

Furthermore, it has already been proposed to manufacture heating elements for high temperatures by surrounding the heating resistor with finely granulated argillaceous earth, placing it into a mold and sintering the surrounding argillaceous earth to a firmly compact protecting sheath by passing an electric current through the conductor. However, it is not possible to provide and to ensure in this manner a perfect sintering of the argillaceous earth particularly in the case of a sufficient thickness of the protecting sheath required in any given structure. Moreover, the powder loosely distributed over the heating element does not sinter so firmly as to result in a gas-tight body. Consequently, the heating elements cannot be used for heating liquids or fuse baths, from which detrimental gases develop. It is not even possible to manufacture the protecting sheath in such a manner as to tightly fit the heating resistor. Either an interstice results, whereby the heat transfer suffers and the entrance of air or gas at the ends of the sheath is unavoidable or the sheath cannot contract to the desired extent during the sintering and the result is the formation of cracks.

According to my invention a perfect protection for heating resistors is obtained if the resistance material which may, as a rule, consist of a metal or a metal compound is surrounded according to ceramic methods with a protecting sheath of refractory material which does not undergo any reactions with the heating resistor and which sinters together with the resistor in the baking furnace in an inert atmosphere at a temperature above 1600° C. until the protecting sheath is completely compact and is firmly applied to the heating resistor.

By ceramic methods such methods are to be understood which are employed in the ceramic industry for the manufacture of shaped bodies which consist, for instance, in moistening the mass to be treated or in rendering it moldable or plastic by adding binding agents thereto and molding it by pressing or forming or converting it into a moldable slip by adding an electrolyte.

Highly refractory metallic oxides, particularly the oxides of aluminum, beryllium, chromium, manganese, magnesium, zirconium, hafnium or mixtures or compounds thereof are particularly suitable for use as materials for the protecting sheath. The materials must be substantially free of argillaceous substances and such containing silicic acid in order that no reactions occur with the resistance material. The protecting sheath is applied, for instance, by introducing the freely suspended resistor member into an absorbing mold of plaster and by pouring into the mold a slip activated with diluted acid. Thin resistor members having a diameter less than 2 mm. may be directly embedded into the mass of the protecting sheath. A completely gas-tight sheath firmly applied to the resistor member is obtained after the sintering. In the case of resistors of larger diameter, the resistor is first surrounded by a temporary intermediate layer or coating prior to the sintering and then the protecting sheath is applied thereto. Wax, paraffin, lac, cellulose, silk, cotton or the like are suitable substances for such an intermediate layer. The thickness of this intermediate layer or temporary coating is so chosen that the space occupied thereby is just enough to permit normal shrinkage of the refractory casing when subjected to the sintering temperature. The ends of the resistors projecting from the protecting sheath are shielded during the sintering process.

As heating conductor any highly refractory metals, such as tungsten, molybdenum or alloys of tungsten or molybdenum may be employed. An alloy of tungsten and molybdenum has proved to be particularly suitable since its coefficient of expansion is approximately equal to that of the protecting sheath consisting in this case preferably of beryllium oxide. Consequently, detrimental changes in the heating resistor which may result in operation owing to a non-uniform expansion or contraction of the heating resistor and protecting sheath are avoided.

In the accompanying drawing some embodi-

ments of my invention are diagrammatically shown.

Fig. 1 illustrates a longitudinal view of a heating element partly in section;

Fig. 2 shows a longitudinal view of a modified form of a heating element partly in section, and

Fig. 3 shows a perspective diagrammatic view of a muffle with a heating element embedded in the wall thereof.

In Fig. 1 the resistor member 1 consists, for instance, of an alloy of tungsten and molybdenum. The ends of the resistor wire 1 are somewhat enlarged as indicated at 2 and joined with other enlargements 3 which partly project from the protecting sheath so that the supply conductors may be connected thereto. The enlargements are, moreover, provided with a spirally wound wire 4 of the same material. The whole is surrounded by the highly sintered protecting sheath 5. The material of the protecting sheath penetrates into the interstices of the spirally wound wires and thereby ensures a perfect sealing at the ends of the sheath.

As shown in Fig. 2 the outer ends 3 of the resistor are tapered within the protecting sheath 5 to the operative heating cross-section of the resistor portion 1. Consequently, the heat is substantially developed only in the thin resistor portion 1, thence it is transferred to the protecting sheath 5, whereas the enlarged ends 3 remain cooler and the portion of the protecting sheath surrounding said enlargements are less heated. Furthermore, the resistor and the protecting sheath are in firm engagement with each other to form a gas-tight heating unit. Contact resistance between the resistor and the ends extending outwardly is avoided.

It is understood that other forms of heating elements, e. g., for immersion in liquids or fuse baths and the like, may be also manufactured.

Furthermore, it is also possible to construct plate-shaped heating elements in accordance with this disclosure which may be used, for instance, for cooking plates. In this case the completely tight sintered protecting sheath may be brought into direct contact with the objects to be heated. As a result of the tight sintering of the protecting sheath a penetration of moisture into the heating conductor is rendered impossible. In the muffle shown in Fig. 3 the spirally wound resistor 1 is completely and gas-tight embedded in the wall 5 of the muffle in the form of a zig-zag line. The material of the muffle contacts directly with the heating element. The supply lead connections 3 are arranged at the rear side of the muffle. The muffle is surrounded in the usual manner with a heat insulation and closed at the front side by a door. The gas-tight embedded heating resistors are completely protected from deteriorations and other influences resulting from the heating gases.

In the same manner electrically heated crucibles may be also manufactured.

The highly sintered, highly refractory metallic oxides have, moreover, the property of being also sufficiently electrically insulating at high temperatures. They are highly resistant to changes in temperature and highly heat conductive so that a rapid heating is effected as well as a uniform and good transfer of heat.

It will be understood from the above explanations that one of the important and essential features of this invention is concerned with a heating element and with a method for making the same, wherein an electrical resistance consisting of a metallic member is embedded or enclosed gastight within a refractory casing of highly sintered metallic oxide.

The term "gas tight" as herein used is understood to mean such a condition with reference to the effect of external gases upon the resistance element as can be objectively ascertained with known and approved standard tests, for example, a test wherein the heating element is immersed in a suitable solution under pressure for a predetermined period of time. If the element has not absorbed any of the test solution during the test, it is then termed "gas tight".

I claim as my invention:

1. A method of making electric heating elements consisting in providing a resistor with a temporary volatilizable coating, surrounding said resistor with a sheath of highly refractory metallic oxide, heating said sheath with the resistor and the coating in a furnace to a high temperature to volatilize said coating, sintering the sheath to a compact and gas-tight body in tight engagement with said resistor, the thickness of said volatilizable coating being so chosen that the space occupied thereby corresponds to the shrinkage of the sheath of highly refractory metallic oxide upon the sintering thereof so that after the sintering the sheath is in a completely gas-tight engagement with the resistor.

2. In a method of making electric heating elements, the steps comprising, taking a metallic resistor, freely suspending said resistor in an absorbing mold, pouring into said mold a plastic slip of highly refractory metallic oxide activated with diluted acid to form a sheath on said resistor, removing said resistor and said sheath from said mold after removal of moisture therefrom and after solidifying said sheath, and heating said resistor and said sheath thereon in a furnace at a temperature exceeding 1600° C. whereby said sheath is sintered unto said resistor to form therewith a permanent gas-tight bond.

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