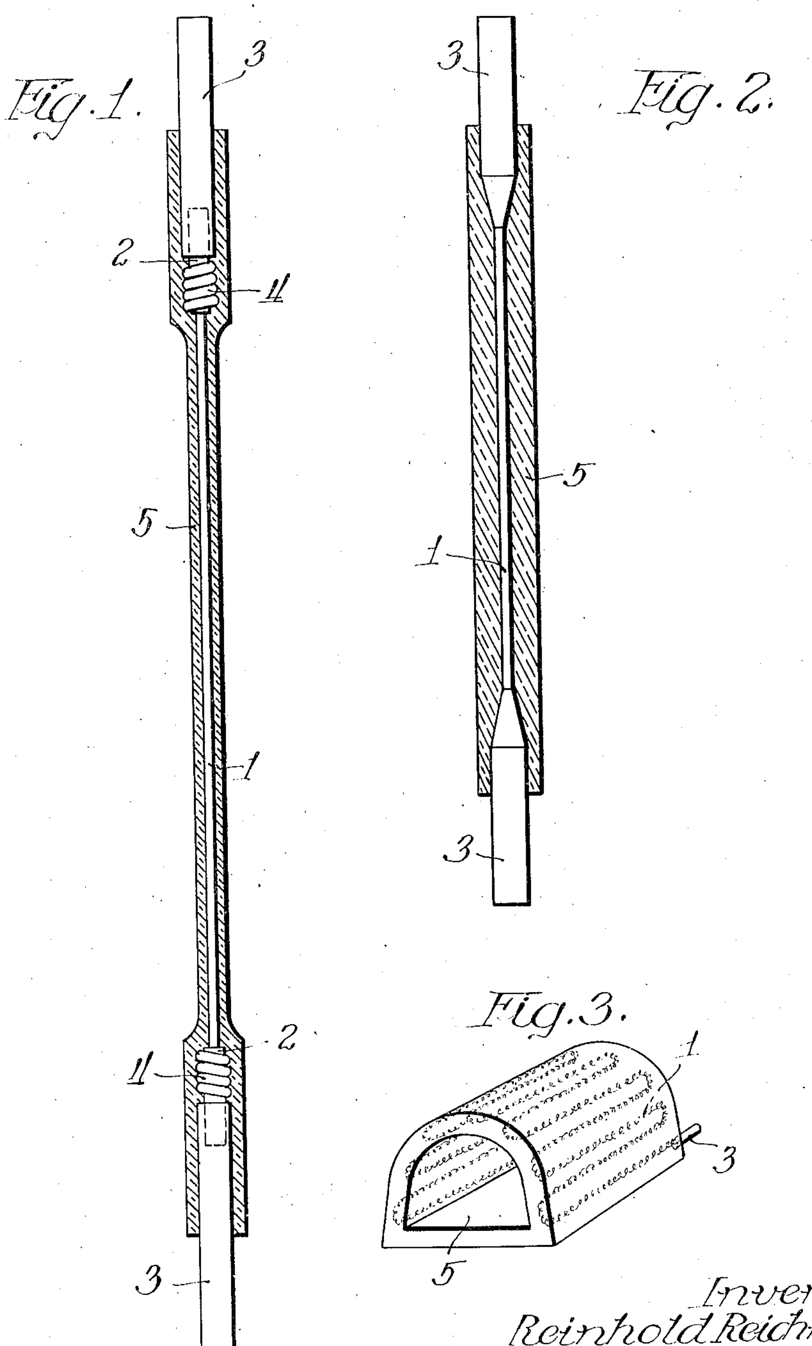
June 28, 1938. R. REICHMANN 2,121,930

HEATING DEVICE AND THE LIKE

Original Filed July 14, 1933



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Atty.

Patented June 28, 1938

2,121,930

UNITED STATES PATENT OFFICE

2,121,930

HEATING DEVICE AND THE LIKE

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Original application July 14, 1933, Serial No. 680,455. Divided and this application March 20, 1935, Serial No. 12,039. In Germany July 15, 1932

3 Claims. (Cl. 201—64)

This invention relates to heating devices and particularly to heating elements and is a division of my co-pending application Serial No. 680,455, filed July 14, 1933 which has matured into Patent No. 2,091,107 dated Aug. 24, 1937.

It is the principal aim of my invention disclosed herein to obtain an improved heating device by the provision of a substantially perfect protection for heating conductors and the like. The conductors are disposed in a protecting sheath of refractory material which does not undergo any reactions with the conductors and furnishes a gas-tight enclosure therefor and a compact unitary structure therewith. The need for such protection of a heating conductor or the like will be apparent from a brief consideration of the following facts relating to the prior art.

Taking, for example, the case of high temperature electric furnaces, it was possible in the past to construct such furnaces only up to reliable operating temperatures of around 1100° C. without using any particular neutral gas. It should be considered that even highly refractory metals oxidize very rapidly in contact with air at high temperatures so that the resistor or heating elements which are usually thin are subjected to rapid deterioration. Higher temperatures may be obtained, for example, by the use of platinum as resistance material. However, platinum has not come into extensive use due to its prohibitive cost and also because it has the tendency to volatilize at high loads. It is therefore subject to recrystallization and as a heating conductor has only a limited durability.

It has also been proposed to produce heating elements for high temperatures by surrounding the heating conductors with finely granulated argillaceous earth, placing the resulting structures into a suitable mold and baking the envelope of argillaceous earth to form a protecting sheath around the conductor by passing an electric current thru the same. However, it is impossible to provide in this manner for a perfect sintering of the argillaceous earth, particularly when it is desired that the protecting sheath should be of sufficient thickness as might be required in a given structure. Moreover, the powdered material which is loosely distributed over the heating element proper does not sinter firmly enough so as to provide a gas-tight envelope for the conductor. Consequently, heating elements made in this manner can not be reliably employed for many purposes, for example, for heating liquids or fuse baths wherein detrimental gases are developed. It is not even possible to produce in the above intimated manner a protecting sheath that fits the heating conductor tightly. Either an interstice results which is detrimental to the heat transfer and promotes the entrance of air or gases at the ends of the sheath, or the sheath does not contract during the sintering to the desired extent and the result is the formation of cracks.

In accordance with my invention, a heating device is produced characterized by a substantially perfect protection of the heating conductor. The heating conductor or resistance material consists as a rule of a metal or a metal compound which may be suitably surrounded, for example, by a ceramic method, with a protecting sheath or envelope of refractory material which may be sintered together with the corresponding resistor or conductor, for example, in a baking furnace in an inert atmosphere at a temperature above 1600° C. until the protecting sheath is completely compact and in gas-tight and firm engagement with the heating conductor. Any suitable method for applying the protecting sheath or envelope on the conductor or resistor may be employed. By referring to ceramic methods, such methods are to be understood which are employed in the ceramic industry for the manufacture of shaped bodies consisting, for example, in rendering the ceramic material moldable or plastic by the addition of suitable binding agents or forming a moldable slip by adding a suitable electrolyte and/or suitably pressing or forming the resulting mixture to obtain the desired shapes or bodies.

I prefer to employ highly refractory metallic oxides for forming the protecting sheath or envelope around a conductor or resistor. The oxides of aluminum, beryllium, chromium, manganese, magnesium, zirconium, hafnium, and the like, or mixtures and/or compounds thereof are particularly suitable. The material used should be substantially free of argillaceous substances or materials containing silicic acid in order to prevent reactions with the resistance material.

Any suitable substance may be used for the heating conductors or resistors of my invention but I prefer to employ highly refractory metal such as tungsten, molybdenum, or alloys of tungsten or molybdenum for this purpose. 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 which may in this case preferably consist of beryllium oxide. Detrimental changes in the heating resistor which may result in operation due to non-uniform expansion or contraction of the heating element and/or of the protecting sheath are thereby substantially avoided.

Some of the embodiments of my invention are shown in the accompanying drawing, in which:

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

Fig. 2 shows a longitudinal view of a modified embodiment; and

Fig. 3 shows a perspective view of a heating device, for example, a muffle with a heating element embedded in the wall thereof.

Like numerals designate like parts throughout the drawing.

The heating member 1, shown in Fig. 1, may consist, for example, of an alloy of tungsten and molybdenum, or of any other suitable material. The ends of the resistor wire 1 are somewhat enlarged as indicated at 2 and are joined with enlargements 3 which project from the protecting sheath or envelope so that the supply conductors may be conveniently attached thereto. The enlargements may also be provided with helically wound wires 4, which may be made of the same material. The entire structure may be surrounded by the highly sintered protecting sheath 5. The material of the protecting sheath penetrates in its plastic condition into the interstices of the helically wound members 4 and thereby contributes toward a perfect sealing of the envelope at the ends of the device.

As shown in Fig. 2, the outer ends 3 of the resistor 1 are tapered within the protecting sheath 5 to the operative heating cross section of the resistor portion 1. Consequently, the heat will be developed principally in the resistor portion 1 from where it will be transferred to the protecting sheath 5. The enlarged ends 3 will remain cooler and the portions of the protecting sheath surrounding the terminal enlargements will be heated less. The resistor and the protecting sheath are in firm engagement with each other and form a gas-tight heating unit. Contact resistance between the resistor and the projecting terminal ends is avoided.

It will be understood from remarks made previously that the protecting sheath 5 may be applied in any suitable manner, for instance, by spraying or painting the oxide insulation on the resistor or by dipping or immersing the resistor in the insulation. However, I prefer to apply the envelope or protecting sheath of metallic oxide by introducing the freely suspended resistor member or element into an absorbing mold made, e. g., of plaster and by pouring into the mold a slip of oxide activated with diluted acid. Thin resistor members having a diameter less than 2 mm. may be directly embedded into the mass forming the protecting sheath. A completely gas-tight sheath which attaches firmly to the resistor member is obtained after sintering the dried unit. In the case of resistors of larger diameter, the resistor may be first surrounded by a temporary intermediate layer or coating and the protecting sheath of oxide is then applied thereto. Wax, paraffin, lac, cellulose, silk, cotton, or the like may be used for forming the intermediate layer. The thickness of this intermediate layer or temporary coating is chosen so 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 resistor projecting from the protecting sheath may be shielded during the sintering process, which may be carried out as previously explained. It may be noted at this point that the sintering temperature may be varied if desired or necessary in a given case. The time of curing or sintering is likewise subject to variation, and the heat may be applied, if desired, either externally or by internal heating in air, vacuum, in a protected atmosphere, or in the presence of inert gases, etc.

It is to be understood that other forms of heating devices or elements may also be produced in accordance with my invention. Since I obtain a protective structure for the heating conductor or resistor which envelopes the same, gas-tight, I am enabled to produce heating elements which may be immersed in liquids or fuse baths or the like. It is also possible to produce plate shaped heating elements or devices in accordance with my invention, for instance, devices that may be used for cooking or heating plates. The objects to be heated may be brought into direct contact with the sintered protecting sheath surrounding the heating conductor or conductors. Moisture will not penetrate into the device in view of the fact that the protecting sheath is tightly sintered onto the heating conductor. Electrically heated crucibles may also be produced in accordance with my invention. Other applications of my teaching will suggest themselves to those skilled in the art.

Fig. 3 illustrates another embodiment of my invention showing a heating device, for example, a muffle wherein the helically wound resistor 1 is completely embedded in a gas-tight manner in the wall 5 in the form of a zigzag line. The material of the muffle may again consist of metallic oxide and contacts directly with the heating element. Supply or terminal connections designated in the drawing by numeral 3 may be provided in the rear of the device. The device may be surrounded in the customary manner with suitable heat insulation and closed at the front by means of a suitable door or shutter. The heating resistors which are embedded gas-tight in the insulating material are effectively protected against any influences resulting for example from the heating gases and will not deteriorate.

The highly sintered, highly refractory metallic oxides used in practicing my invention are electrically insulating at high temperatures. They are highly resistant to temperature changes and highly heat conductive so that a rapid heating as well as a uniform and good transfer of heat are effected.

It will be understood from the above explanations that one of the important and essential features of this invention is concerned with the production of a heating device or element wherein an electrical conductor or resistor consisting of a metallic member is embedded or enclosed gas-tight 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 does not absorb the test solution during the test, it may then be termed—"gas-tight".

My invention may be employed for successfully producing devices, e. g., furnaces and the like arranged for operation at temperatures ranging around and/or above 1600° C. which corresponds to the sintering temperature applied in the example described previously.

Changes may be carried out, if desired, within the scope and spirit of the appended claims.

I claim as my invention:

1. As an article of manufacture, a heating unit for an electric furnace or the like, said unit comprising a metallic heating section of uniform diameter, said heating section having a terminal section at each end thereof of enlarged diameter, a helical member wound around each terminal section, and an impervious sheath of sintered metallic oxide covering said heating section, said helical members and a substantial portion of each terminal section, said sheath tightly gripping said terminal sections and helical members due to shrinkage in the sintering operation and serving thereby to seal the entire heating section against the entrance of gases.

2. As an article of manufacture, a heating unit for an electric furnace or the like in which the heating units are exposed to the air and relatively high temperatures on the order of 1600° C. are attained, said unit comprising a metallic rod structure having a section at each end of enlarged diameter and a heating section of smaller diameter between, each enlarged section having a helical member wound around it for a portion of its length, and a sheath of metallic oxide sintered on said rod by the application of heat, said sheath covering also the said helical members at the ends of said rod structure and being effective to seal the entire heating section against the entrance of gases.

3. An electrical heating unit for producing in normal operation without the use of any protective gaseous medium temperatures ranging around 1600° C., said unit comprising a tungsten resistor, a terminal at each end of said resistor, a helical member wound around each terminal, and insulating means for enclosing said resistor gas-tight, said insulating means being formed of highly sintered aluminum oxide placed about said resistor and entering the grooves in said helical members, thereby forming a unitary gas-tight enclosure for said resistor.

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