June 13, 1944. H. S. COOPER 2,351,490

TERMINAL FOR VACUUM-TYPE FURNACES

Original Filed March 21, 1942

Fig. 1.

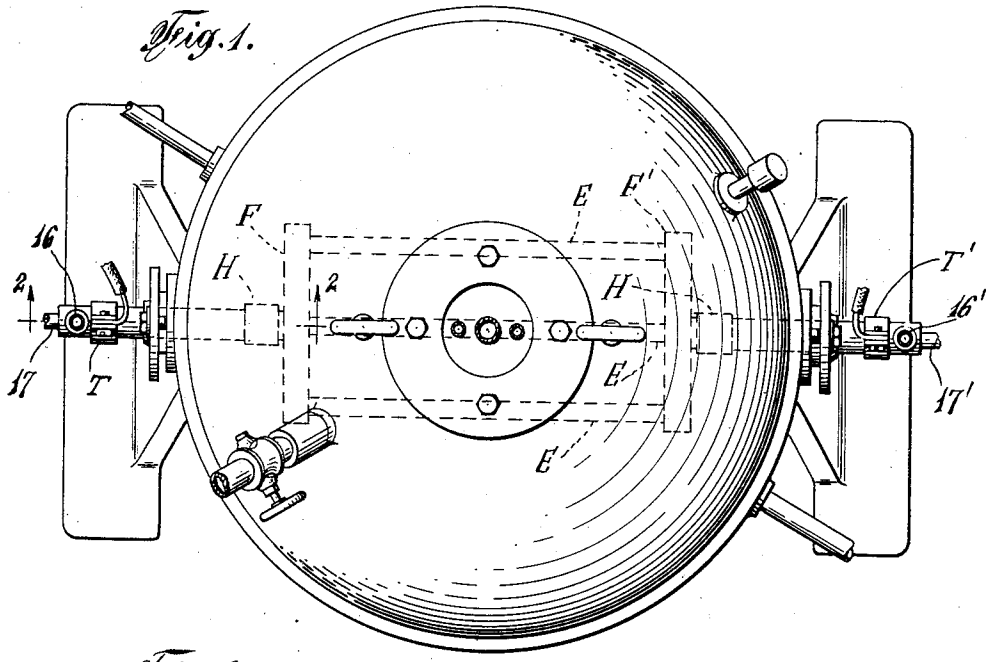


Fig. 2.

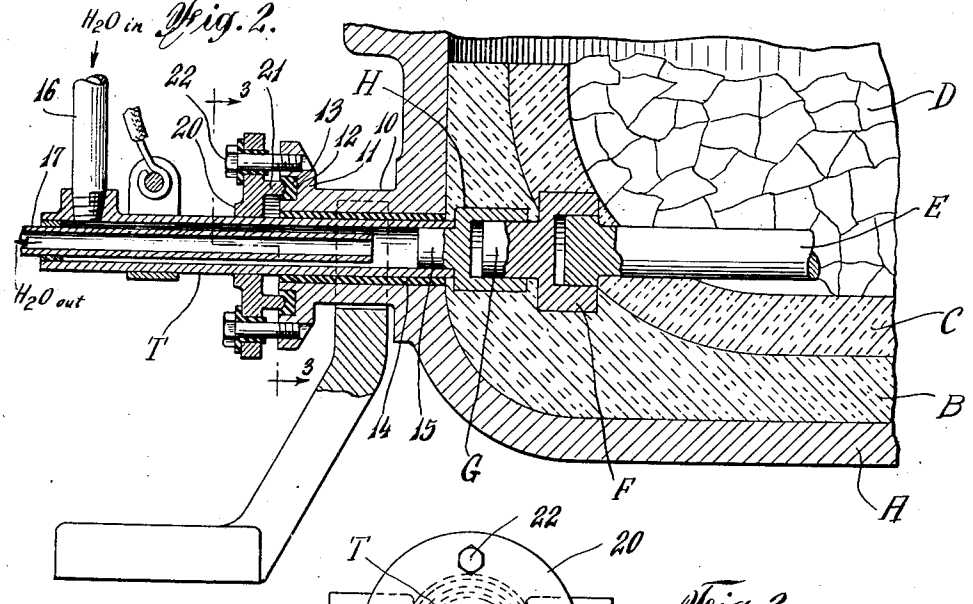
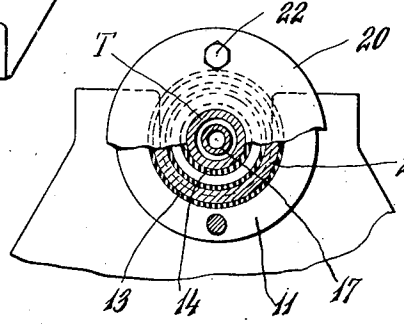


Fig. 3.



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TERMINAL FOR VACUUM-TYPE FURNACES

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Original application March 21, 1942, Serial No. 435,678. Divided and this application July 7, 1943, Serial No. 493,723

7 Claims. (Cl. 13—25)

This invention relates to electrical resistance furnaces and more particularly to electrical resistance furnaces of the type provided with means to hermetically seal the interior of the furnace from the atmosphere and to provide therein a desired atmosphere at a determined pressure ranging from atmospheric pressure to high vacuum.

In such furnaces one of the problems involved is to provide means to conduct the electric current from a source exteriorly of the furnace to the electrical resistance heating element interiorly located within the furnace through a vacuum tight joint closing an opening in the furnace walls in a detachable electrically insulated connection maintaining electrical contact with the expanding and contracting heating element within the furnace over a wide range of atmospheric pressure differentials between the interior and exterior of the furnace.

One of the objects of the present invention is to provide such a means for this type of furnace.

Another object is to provide an improved terminal for such furnaces which is detachably secured within an opening in the furnace wall and is electrically insulated from the furnace wall in a flexible gas tight joint providing for the movement of the terminal axially in response to pressure differentials between the interior and exterior of the furnace with the inner end of the said terminal in sliding engagement with the end of the heating element contained within the said furnace, thereby providing for the maintenance of electrical contact therebetween over a wide range of expansion and contraction movement of the said element as a result of temperature and atmospheric pressure variations within the furnace.

Other objects and advantages will be apparent as the invention is more fully hereinafter disclosed.

This application is a division of my copending application Serial No. 435,678 filed March 21, 1942.

In accordance with the above objects I have devised the means illustrated in the accompanying drawing to accomplish the desired results, wherein—

Fig. 1 is a top view of a low pressure metallurgical furnace incorporating the present invention:

Fig. 2 is an enlarged section along plane 2—2 of Fig. 1 illustrating the details of the present invention; and

Fig. 3 is a sectional view along plane 3—3 of Fig. 2.

As may be seen from the drawing, the low pressure metallurgical furnace incorporating the present invention consists essentially of two hemispherical metal shells joined together with a vacuum seal union forming the subject matter of my said copending application Serial No. 435,678, above noted, the specific details of which need not be herein described.

The bottom metal shell A is interiorly lined with refractory material B surfaced with aluminum silicate C ($Al_2O_3.SiO_2$), substantially as indicated in Fig. 2 to form a shallow hearth in the bottom of which hearth is located electrical resistance elements E. The charge of briquets D is disposed on the hearth in direct thermal contact with heating elements E.

Heating elements E consist of elongated bars or rods of any suitable high resistance electrical conductor, such as, for example, any one of the heretofore well known Cr-containing alloys of Fe, Co and Ni, or may consist of a highly refractory metal such as tungsten or molybdenum, or alternatively may consist of carbon. The particular composition of the heating element E forms no part of the present invention.

In the arrangement shown in the drawing, the bars or rods E are electrically connected in parallel to end conductors F—F', which are embedded within the refractory linings B and C. Normally, end conductors F—F' are of such size and cross-section and electrical resistance relative to bars or rods E to conduct the electric current to rods E without substantial incandescence. Each end conductor F—F' is provided with an extension G, preferably centrally located thereon and preferably, also, cylindrical in shape substantially as shown, which extension G is enclosed by an end plug H provided with a recess into which extension G may slidably seat in a relatively tight and electrical conducting fit, the depth of the recess being adapted to receive the full length of extension G therein.

Normally, however, plug H is located with respect to the extension G substantially as indicated in Fig. 2 to provide clearance for axial movement of extension G within the recess as a result of thermal expansion and contraction of the end conductor F, and rod E is similarly mounted within a recess in end conductors F—F' to provide for axial thermal expansion and contraction of the rod E during incandescence and cooling.

With this arrangement of heating elements E electrically connected in parallel by sliding contacts to end conductors F—F' which in turn are

electrically connected by sliding contacts to plugs H—H', there remains the problem of providing for the conducting of the energizing electric current from a source exterior the furnace to the interior of the furnace through an opening in the shell A, in a manner which will preserve the low pressure conditions desired within the furnace and at the same time make a connection with plug H which is substantially non-rigid.

This is accomplished in accordance with the present invention by providing a tubular extension 10 about the opening in shell A through which the electrical connection to plug H is to be made, with the outer edge of the tubular extension 10 provided with an annular flange 11 having the outer face thereof lying in a plane normal to the axial centers of the opening and tubular extension 10. In this outer face, I provide an annular recess 12 within which is disposed an annular packing consisting of a resilient material, preferably rubber. The inner surface of tubular extension 10 is provided with a refractory electrical insulation coating or member 14, such as alundum (aluminum oxide) coating or tubular member.

Terminal T is provided to conduct the electric current from a source exterior the furnace through the opening in shell A to plug H. Terminal T comprises a metal tube having an outside diameter approximating but less than the inside diameter of tubular extension 10 (minus the thickness of the refractory insulation 14), and having an inside diameter at least at the forward end approximating but larger than tubular extension 15 on plug H adapting said forward end to be engaged with said extension 15 in a mechanically tight fit operative to provide watertight seal joint therebetween to provide for the circulation of water under pressure through conduit 16 to the interior of tube T onto the enclosed end 15 of plug H and thence out of tube T through inner tube 16 to a discharge point.

Terminal T is provided midway its length and at the appropriate distance from the inner end thereof, with an annular extension 20 having an annular rib 21 thereon substantially concentric to the longitudinal axis of the tube T and extending towards the forward end thereof, the diameter of the rib 21 approximating the diameter of recess 12 in flange 11 and the width thereof being less than the width of recess 12 thereby to be adapted to be seated upon resilient filling 13 contained in the said recess 12.

The location of annular extension 20 on tube T is arranged such that when rib 21 is located in sealing position upon resilient material 13 and is mechanically sustained in said position by means such as bolts 22 passing loosely through electrically insulated openings in flange 20 with the threaded ends thereof engaging in threaded recesses in flange 11, the resiliency of flexible material 13 in recesses 12 is such as to permit axial movement of tube T in response to variations in the internal atmospheric pressures within the furnace while maintaining electrical contact with extension G by means of the sliding contact provided between extension G and plug H.

With the arrangement shown, it is only necessary to sustain terminal T in the position indicated by bolts 22 with rib 21 in hermetic seal contact with the surface of resilient material 13 at pressures within the furnace approximating atmospheric pressure. This requires only a relatively slight amount of pressure by means of bolts 22. Subsequently, as the pressure within the furnace is lowered below atmospheric pressure, the air pressure on the outer surface of annular extension or flange 20 forces terminal T inwardly with resultant increased pressure of rib 21 against resilient material 13 and consequent better hermetic seal relationship therebetween. This inward movement of terminal T is absorbed by the sliding electrical connection between plug H and extension G on end conductor F.

Thereafter upon incandescing heating elements E by the passing of an electric current therethrough, any expansion and contraction between the elements E and end connector F—F' will be absorbed by the sliding connection provided therebetween and in the sliding connection between plug H and extension G.

The arrangement provided as hereinabove described and illustrated in the drawing may be widely modified without essential departure from the present invention as one skilled in the art may perceive and is adapted to wide use in all types of electrical devices wherein it is desired to provide for the passage of an electric current through a container wall to a heating element within the container in a manner providing for the expansion and contraction of the heated element as well as for the maintaining of a hermetic sealing of the opening in the container wall through which the terminal extends. In view thereof, all such modifications and adaptations of the present invention are contemplated as may fall within the scope of the following claims.

What I claim is:

1. In an electrical device having a container wall with an opening therein through which extends an electrically conductive terminal, the inner end of which is to be electrically connected to an electrical resistance heating element, means sustaining said terminal within the said opening in a flexible hermetic joint between the terminal and the outer surface of the container wall about the said opening while permitting axial movement of the terminal inwardly from the sustained position against the resiliency of the flexible material comprising the hermetic joint while maintaining the said hermetic seal joint and means providing a sliding electrcal contact between the inner end of said terminal and said heating element, said sliding contact absorbing the axial movement of said terminal and the thermal expansion and contraction of the said heating element while maintaining electrical contact between the terminal and heating element.

2. In the combination of claim 1, said first mentioned means consisting of cooperating annular flanges lying in the same plane at right angles to the longitudinal axis of the said terminal, one said flange being fixedly sustained upon a tubular extension on the container wall surrounding the opening therein through which the said terminal extends and being provided with an annular recess in the surface thereof facing the other said flange and concentric about the center axis of said opening within which is seated an annular packing consisting of resilient material, and the other said flange being sustained as a flange extension of the outer surface of said terminal and being provided with a rib extension on the surface facing the first said flange, the diameter of said rib extension approximating that of the said recess and being disposed concentric to the longitudinal axis of the said terminal, and means to mechanically sustain the said terminal within the said opening with the said rib in hermetic pressure seal

contact with the said resilient material in said recess but unrestrained with respect to further movement of the terminal axially in a direction opposed by the resiliency of the said resilient material.

3. In the combination of claim 1, said last mentioned means consisting of a terminal end provided with a cylindrically shaped recess and a heating element provided with a cylindrically shaped extension seating within said recess and making an electrical sliding contact therebetween, the depth of the said recess and length of said extension being selected with respect to the amount of axial movement provided in the said flexible hermetic seal joint to provide an electrical contact therebetween over the entire range of axial movement provided in said joint.

4. Means providing for the conduction of an electric current through an opening in the metallic enclosure of an electric device and closure of the said opening to the passage of gases therethrough, said means consisting of a pair of cooperating annular flanges, one mounted upon the end of a tubular extension concentrically about the opening in said enclosure and the other mounted concentrically upon the exterior surface of an electrical terminal disposed within said opening, the opposing faces of said flanges being provided, respectively, with an annular recess filled with a packing consisting of resilient material and a rib extension each concentrically disposed about the center axis of the said opening and terminal respectively and adapted to be seated one within the other, and means to mechanically sustain the said terminal within the said opening with the said rib in electrically insulated gas-tight engagement with the said resilient material but free to move in the direction opposed by the resiliency of said material a distance limited by the heighth of said rib extension.

5. In an electrical resistance furnace of the vacuum type provided with an enclosing metallic shell having an opening therein and an electrical terminal extending through said opening for conducting the electric current through the shell to the interior of said furnace, means for detachably securing the said terminal in position in said opening in a flexible gas-tight mounting, said means comprising in combination a tubular extension on the outer face of the said shell concentrically located about the said opening, an annular flange on the outer end of said tubular extension having an outer face lying in a plane at right angles to the axis of said opening and tubular extension, an annular recess in said outer face disposed concentrically about the said axis of said tubular extension, a packing consisting of resilient material in said recess, a second annular flange forming an extension of the outer surface of said terminal, said flange having a face thereof opposite the outer face of said first annular flange provided with an annular rib extension located concentrically about the terminal axis and having a diameter approximating the diameter of said annular recess in the first said flange, and means to sustain the said terminal within the said opening with the said rib extension seated upon the said resilient packing material in said recess under a sustained pressure maintaining a gas-tight joint therebetween at atmospheric pressures with the terminal free to move inwardly against the resiliency of the said packing material a distance limited by the heighth of said rib extension, said means also including means to electrically insulate the said terminal from the enclosing metallic shell.

6. In an electric furnace of the electrical resistance type provided with a metallic outer shell hermetically sealing the interior of the furnace from the atmosphere and provided with means to provide therein a preferred atmosphere at a determined pressure ranging from atmospheric pressure to substantial vacuum, means to conduct the electric current from a source exteriorly of the furnace to the heating element within the said furnace through the said outer shell, said means comprising an elongated electrically conductive terminal member extending through an opening in the said shell, the outer end of said terminal member being electrically connected to a source of electrical current and the inner end of said terminal member being connected in axial sliding electrical contact with the said heating element, an annular collar extension on the outer face of said shell about the opening therein through which the said terminal extends, an annular recess in the end of said collar, an annular piece of resilient material seated in said recess the outer face thereof lying in a plane normal to the longitudinal axis of said terminal, an annular rib extension on said terminal having a diameter approximating the diameter of said annular piece of resilient material and located in a position on said terminal to make seating engagement therewith when the said terminal is located within the said opening, means mechanically securing the terminal in electrically insulated position within said opening with the said annular rib extension and annular resilient piece in hermetic sealed relation to each other, said means providing for the substantially free movement axially of the said terminal inwardly but restricted as to movement outwardly from the said mechanically secured position, and means to maintain the temperature of the said resilient material and the said annular rib member contacting therewith below the temperature at which the resiliency of the said material is detrimentally effected thereby to maintain the hermetic seal relationship therebetween.

7. In a vacuum furnace, an electrode sealing means, said means comprising two cooperating parts, one consisting of an annular gasket consisting of resilient material and the other consisting of an annular rib extension, each said part being sustained in engaging position about the said electrode exteriorly of the furnace, one of the engaging parts being integral with the exterior face of the furnace wall about the periphery of an opening therein through which the electrode extends to the furnace interior and the other said part being integral with the said electrode, and means to bring the two said parts together in sealing engagement, said means providing for further movement of the electrode inwardly towards the furnace interior upon a reduction of the pressure of the atmosphere contained therein below atmospheric pressure but restraining movement of the electrode away from the furnace interior at all pressures above atmospheric pressure within the said furnace interior.

HUGH S. COOPER.