Oct. 31, 1950 L. J. POUCHNIK ET AL 2,527,890

TUBULAR HEATER TERMINAL SEAL

Filed March 21, 1949

Fig. 1

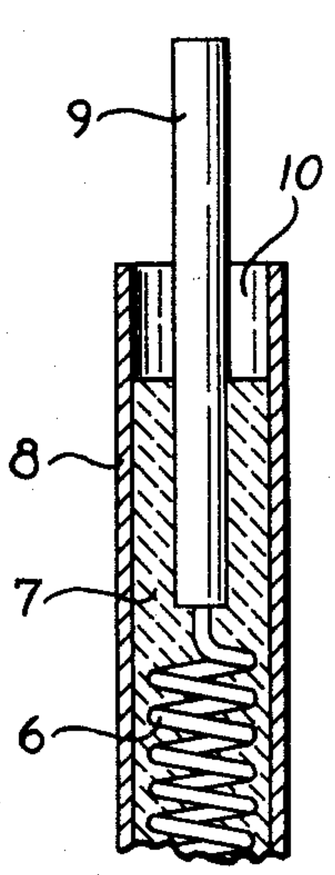


Fig. 2

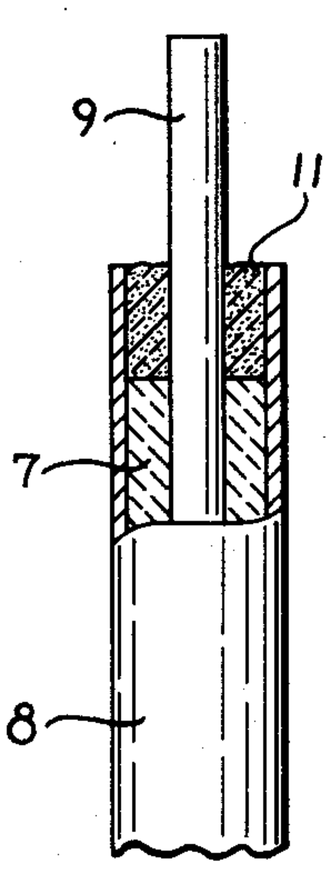


Fig. 3

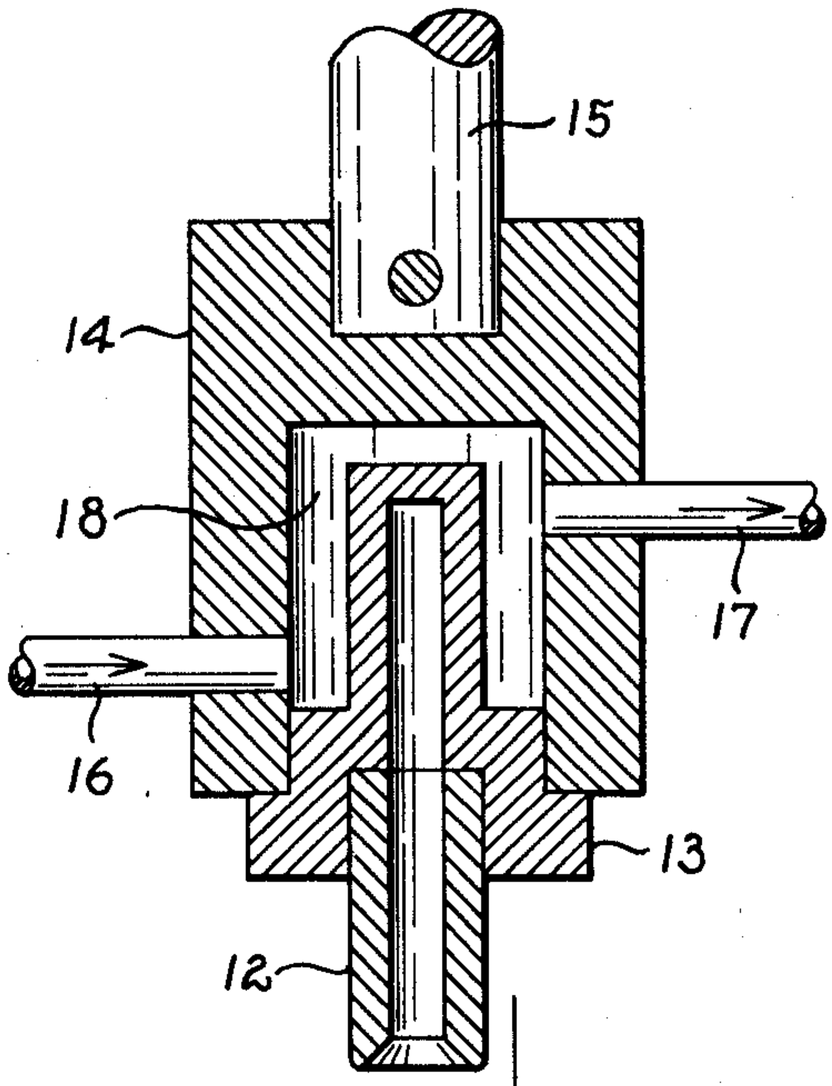


Fig. 4

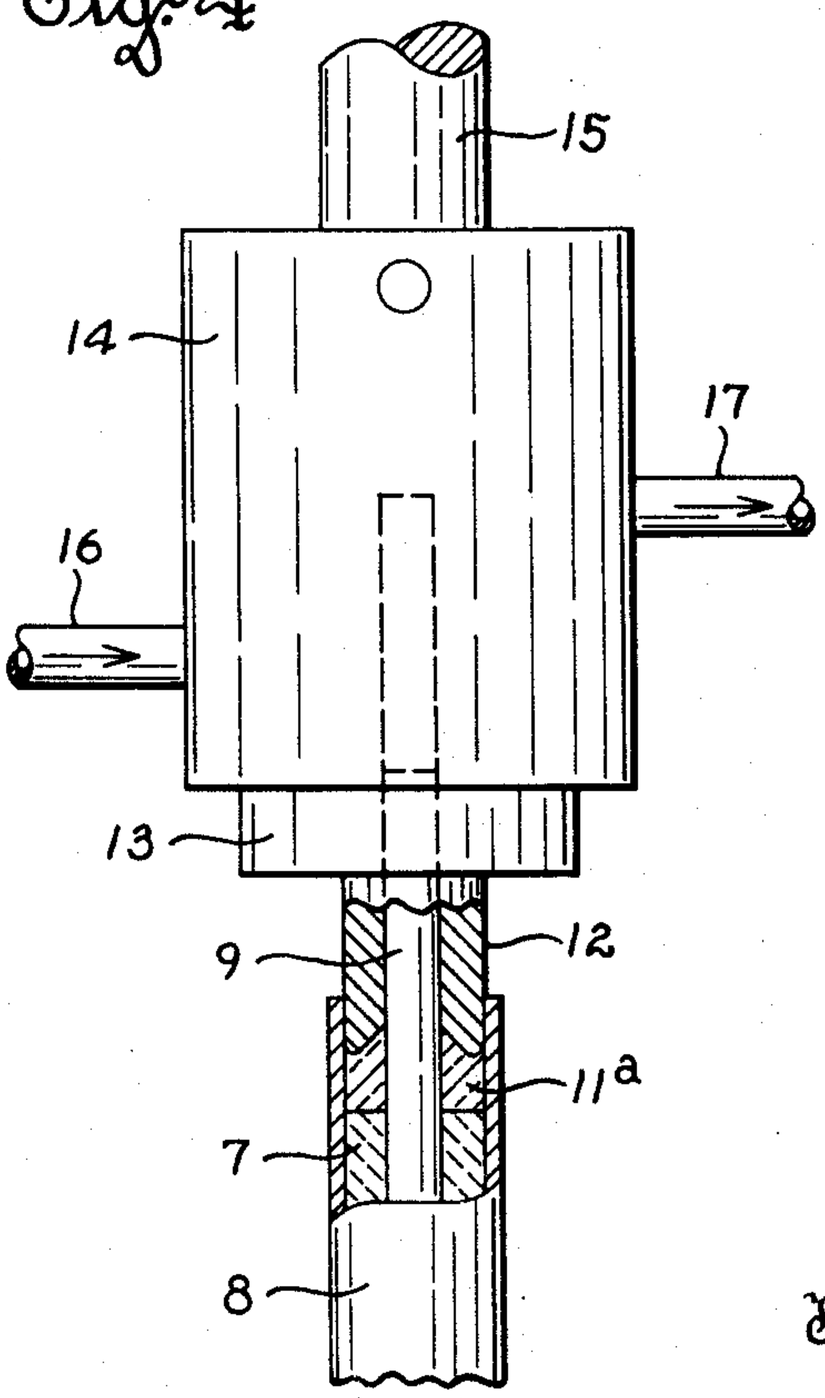
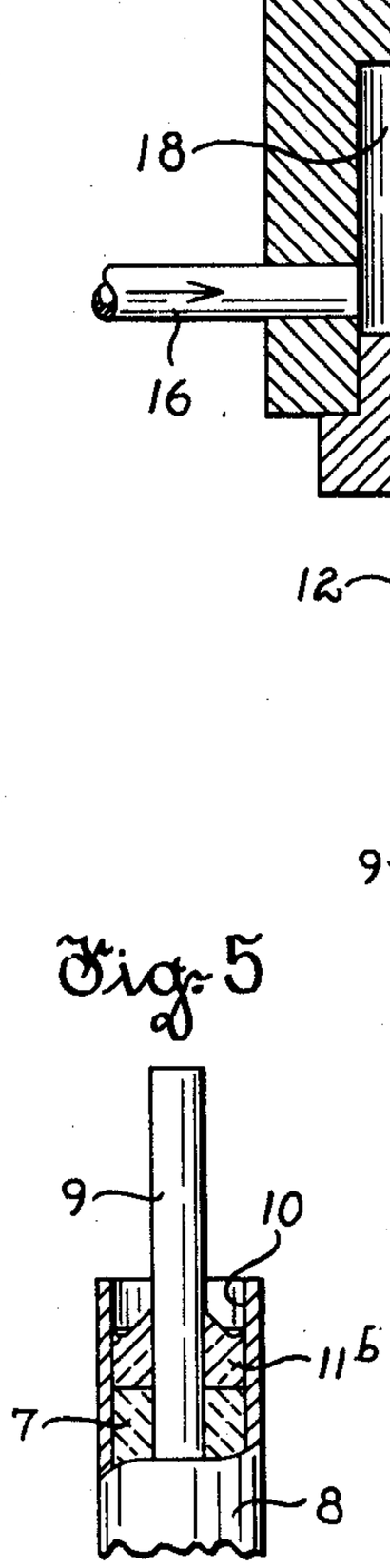


Fig. 5



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Patented Oct. 31, 1950 2,527,890

UNITED STATES PATENT OFFICE

2,527,890

TUBULAR HEATER TERMINAL SEAL

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Application March 21, 1949, Serial No. 82,586

7 Claims. (Cl. 201—67)

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This invention relates to electric heaters and more particularly to an improved method and means for sealing the terminal ends of heaters having tubular enclosing sheaths.

It is a primary object of the present invention to provide for sealing the terminal ends of such heaters in a simple and expeditious manner.

Another object is to provide for sealing in such a manner that gases that may be generated within the heater during the process of sealing cannot render the resulting seals imperfect.

Another object is to provide terminal end seals which are impervious to liquids, moisture, vapors and gases.

Another object is to provide a terminal end seal which is characterized by unusual electrical resistivity, mechanical toughness and strength.

Other objects and advantages of the invention will hereinafter appear.

The accompanying drawings illustrate an embodiment of the invention which will now be described; it being understood that the embodiment is susceptible of various modifications without departing from the scope of the appended claims.

In the drawings:

Figure 1 is a view in longitudinal section of a portion of a tubular type heater prior to application of a terminal seal; the terminal lead and the resistor being shown in elevation.

Figure 2 is similar to Fig. 1, but shows the heater at one stage during the application of a terminal seal.

Figs. 3 and 4 show the heater at successively later stages during the application of a terminal seal, and show processing apparatus which may be employed, and

Fig. 5 is a fragmentary sectional view showing the terminal seal in a completed state; the terminal lead being shown in elevation.

Referring to Fig. 1, it shows a tubular type electric heater comprising a helical resistor 6 which is embedded in a compacted mass of refractory insulating material 7, such as magnesium oxide, and incased by a tubular sheath 8 of any preferred cross-sectional form. The resistor 6 is connected in any preferred manner to a terminal lead 9 which extends outwardly of sheath 8. The sheath adjacent its end is unfilled and provides a recess 10 to receive the terminal seal.

The heater as shown in Fig. 1 is ready for application of the terminal seal; it being assumed that the greater portion of the working or swaging of the heater to compact the insulating material 7 and to provide the desired cross-sectional dimensions for the heater has been accomplished and that the heater has been subjected to an annealing treatment to remove the stresses incurred during such working and to remove a greater percentage of the moisture entrained in the insulating material 7. Further it is assumed

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that in preparation for the application of the improved terminal seal the inner surface of the sheath 8 surrounding recess 10 has been suitably cleaned.

Referring to Fig. 2, a quantity of suitable vitreous material 11 in powdered form is placed in the recess 10 in such amount that said recess is completely filled. It has been found that vitreous materials suitable for use with the sealing process to be hereinafter described are preferably of the pre-fused type wherein the component constituents substantially all go into solution to provide a homogeneous mixture which is amorphous in character.

As the character of the resulting terminal seal depends to a great extent upon the character of the component constituents of the material 11, care should be exercised in the selection of such constituents. When such material is subsequently re-fused and solidified into a solid mass, the material should have a coefficient of linear thermal expansion closely approximating that of the materials of which the sheath 8 and the terminal lead 9 are formed and should retain its solidity at the temperatures attained by the terminal end portions of the heater when the latter is energized. Further, when so re-fused and solidified, such material should have relatively high electrical resistivity and be resistant to mechanical breakage. There are several commercially available vitreous materials which will meet the above recited requirements and which will provide satisfactory terminal seals when treated in accordance with the method now to be described in detail. However, applicants have found that a certain vitreous composition described in the application of Fred H. Kaufmann, Serial No. 73,673, filed January 29, 1949, and issued as Patent No. 2,527,884 on even date herewith, is preferred as a sealing medium. The constituents of the preferred vitreous composition and percentages of each by weight based on the total weight of such composition as given in Table III of the aforementioned application are as follows:

	Per cent
Silica (SiO_2)	27.68
Boric Oxide (B_2O_3)	7.33
Fluorspar (CaF_2)	18.76
Barium Oxide (BaO)	37.69
Zinc Oxide (ZnO)	5.63
Alumina (Al_2O_3)	1.92
Cobalt Oxide (CoO)	0.99

The material 11 may be placed in recess 10 in any convenient manner; an expeditious way of doing this being to force the end of the heater into a powdered mass of such material as by hand so as to cause the material to be forced into and completely fill recess 10 in a semi-compacted state.

Then the portion of sheath 8 coextensive with recess 10 is subjected to localized heating to effect fusion and/or liquefaction of the material 11. Such heating may be done in any preferred way, for example, by subjecting such portion of sheath 8 to the heat of a plurality of gas flames.

When the material 11 has become re-fused and has attained a homogeneous liquid or plastic consistency, heating of the sheath 8 is terminated and a pressure plunger or punch 12, shown in Figs. 3 and 4, is fitted over the terminal lead 9 and moved downwardly and inwardly of the recess 10 so as to exert pressure on the fused but unsolidified matreial which in Fig. 4 is designated 11a instead of 11 in view of its altered state. The pressure applied by the punch 12 on the material 11a should be on the order of 2100 pounds per square inch and the duration of such pressure need not exceed two or three seconds. Punch 12 during such operation should be maintained at ordinary room temperature, and preferably lower, to insure that the material 11a will not stick or adhere to the punch.

Application of the aforementioned amount of pressure on the fused but unsolidified material 11a in the manner aforedescribed effects a reduction in the volume of such material to substantially one-half its original volume, thus densifying the same to a large degree. Such densification of the material 11a eliminates any voids or pockets which may form as an incident to re-fusion the material. Further, the relatively cool pressure applying punch tends to effect rapid solidification of the material 11a into a solid body designated 11b. While some gases may be generated in the insulating material 7 as a result of the heating of the sheath 8 as aforedescribed and would have a tendency to form bubbles or pin holes in the material 11a during solidification, the counteracting pressure and rapid solidifying action imparted by the punch 12 prevents this from occurring.

After completion of the aforementioned pressure applying operation on the material 11a and after the latter has solidified, the solid fused vitreous body 11b results in the recess 10 of the heater, the punch 12 preferably being shaped to afford the body 11b the form shown in Fig. 5. The body 11b thus formed strongly adheres in a bonded relation to the inner surface of sheath 8 and to the terminal lead 9 and provides a sealed barrier against the ingress or egress of moisture, vapors or gases into or from the insulating material 7. Assuming that the composition of the material 11 initially used in the sealing operation meets the requirements aforementioned, the resulting seals will retain their bond and solidity at the temperatures attained by the terminal end portions of the heaters when the latter are energized. The preferred vitreous composition aforementioned, if used as the sealing medium in connection with the sealing process hereinbefore described, results in terminal seals which meet all of the aforementioned requirements and in addition have unusually high electrical resistivity, on the order of 61 megohms at 760° F., and unusual mechanical toughness, being able to withstand mechanical shocks on the order of 2000 foot-pounds without damage thereto or breakage of bond with the sheath 8 and terminal lead 9.

As will be understood, the successful carrying out of the sealing method herein described is not dependent upon use of the specific form of pressure applying plunger or punch 12 shown in Figs. 3 and 4. However, this form of punch has been found to be highly satisfactory in applying the requisite pressure on the material 11a. It is particularly adapted to a series of such operations in closely spaced intervals, such as would obtain in a high production set-up, due to provision for subjecting it to the influence of a cooling medium. More specifically the punch and its associated parts comprise the punch 12, a carrier block 13, an intermediate member 14, a shaft 15, and coolant conducting conduits 16 and 17. The punch 12 is preferably made of hardened steel. Block 13 is made of a high heat conducting metal such as copper. With the punch 12, block 13, member 14, and conduits 16 and 17 formed and assembled as shown, a chamber 18 is provided in which a cooling medium such as water may be circulated by virtue of the conduits 16 and 17. Continuously subjecting the punch 12 to influence of circulating water at ordinary supply temperatures will insure that in repeated pressure applying operations the material 11a will not stick or adhere to the punch and rapid solidification of such material will be facilitated.

We claim:

1. The method of sealing the terminal end of an electric heater wherein a resistor enclosed in an open end tubular sheath is embedded in insulation terminating at a distance from the end of the sheath to leave the sheath with an open end recess, and wherein the resistor has a terminal portion projecting through said recess to a point beyond the sheath, which comprises filling the end recess with a vitreous material in powdered form, heating locally the end of the sheath to fuse said material, and subjecting said material in fused but unsolidified state to pressure on the order of 2,100 pounds per square inch at least briefly while permitting said material to cool.

2. The method of sealing the terminal end of an electric heater wherein a resistor enclosed in an open end tubular sheath is embedded in insulation terminating at a distance from the end of the sheath to leave the sheath with an open end recess, and wherein the resistor has a terminal portion projecting through said recess to a point beyond the sheath, which comprises filling the end recess with a vitreous material in powdered form, heating locally the end of the sheath to fuse said material, and subjecting said material in fused but unsolidified state to pressure on the order of 2,100 pounds per square inch at least briefly while permitting said material to cool, maintaining in a relatively cool state the pressure applying means.

3. The method of sealing the terminal end of an electric heater wherein a resistor enclosed in an open end tubular sheath is embedded in insulation terminating at a distance from the end of the sheath to leave the sheath with an open end recess, and wherein the resistor has a terminal portion projecting through said recess to a point beyond the sheath, which comprises forcing the end portion of the heater into a powdered mass of vitreous material to effect filling of the end recess with said material in a semi-compacted state, heating locally the end of the sheath to fuse said material, and subjecting said material in fused but unsolidified state to pressure on the order of 2,100 pounds per square inch at least briefly while permitting said fused material to cool, maintaining in a relatively cool state the pressure applying means.

4. The method of sealing the terminal end of an electric heater wherein a resistor enclosed in an open end tubular sheath is embedded in insulation terminating at a distance from the end

of the sheath to leave the sheath with an open end recess, and wherein the resistor has a terminal portion projecting through said recess to a point beyond the sheath, which comprises filling the end recess with a vitreous composition in powdered form, said composition having as its constituents by weight based on the total weight of such composition, 27.68% silica, 7.33% boric oxide, 18.76% fluorspar, 37.69% barium oxide, 5.63% zinc oxide, 1.92% alumina and 0.99% cobalt oxide, heating locally the end of the sheath to fuse said powdered composition, and subjecting said composition in fused but unsolidified state to pressure on the order of 2,100 pounds per square inch at least briefly while permitting said composition to cool, maintaining in a relatively cool state the pressure applying means.

5. The combination with a tubular heater comprising a resistor having a terminal portion, an open end tubular sheath surrounding said resistor and also its terminal portion in part, and insulation in said sheath retaining said resistor in spaced relation to said sheath, said insulation terminating at a distance from the end of said sheath leaving said sheath with an open end recess through which said terminal portion projects, of a seal for the terminal end of said heater comprising a solidified body of vitreous material occupying at least a portion of the recess in said sheath and adhering in bonded relation with said sheath and said terminal portion, said vitreous material consisting of a fused mixture of 27.68% silica, 7.33% boric oxide, 18.76% fluorspar, 37.69% barium oxide, 5.63% zinc oxide, 1.92% alumina and 0.99% cobalt oxide.

6. The method of sealing the terminal end of an electric heater wherein a resistor enclosed in an open end tubular sheath is embedded in insulation terminating at a distance from the end of the sheath to leave the sheath with an open end recess, and wherein the resistor has a terminal projecting through said recess to a point beyond the sheath, which comprises filling the end of the sheath with a vitreous material in powdered form, heating said vitreous material in situ to fuse the same, and subjecting said material in fused but unsolidified state to mechanical pressure on the order of 2,100 pounds per square inch at least briefly while permitting the material to cool.

7. The combination with a tubular heater comprising a resistor having a terminal portion, an open end tubular sheath surrounding said resistor and also its terminal portion in part, and insulation in said sheath retaining said resistor in spaced relation to said sheath, said insulation terminating at a distance from the end of said sheath leaving said sheath with an open end recess through which said terminal portion projects, of a seal for the terminal end of said heater occupying at least a portion of the recess and adhering in bonded relation to said sheath and said terminal portion, said seal consisting of a homogeneous mass of solidified vitreous material formed in situ of a vitreous composition of the pre-fused type by re-fusion and application of a relatively high degree of mechanical pressure thereto at least briefly during solidification.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,043,196	Finlayson	June 2, 1936

FOREIGN PATENTS

Number	Country	Date
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