

Dec. 20, 1955

H. ALTOSAAR
IMMERSION HEATERS

2,727,979

Filed Jan. 6, 1953

3 Sheets-Sheet 1

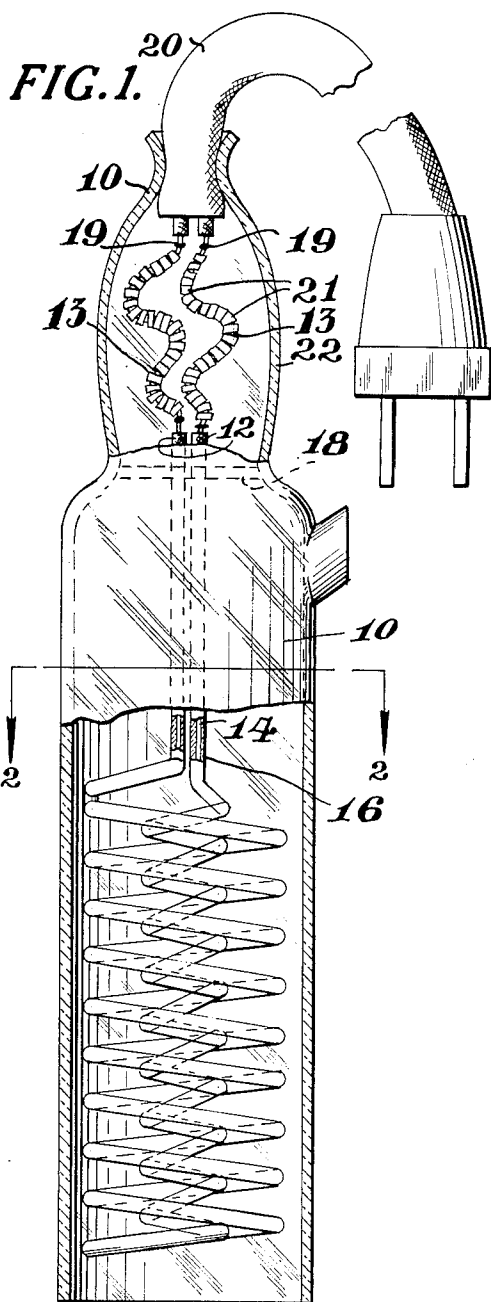


FIG. 2.

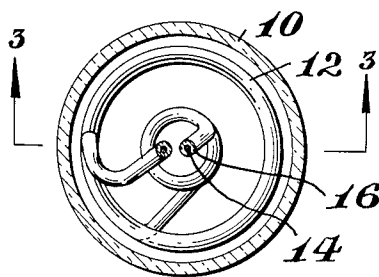
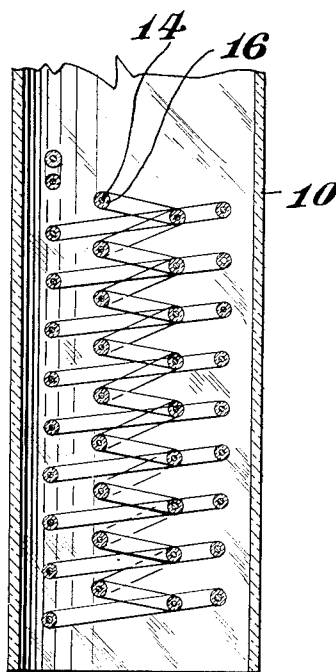


FIG. 3.



INVENTOR
HEINO ALTOSAAR

BY

Wan Aulabey

ATTORNEY

Dec. 20, 1955

H. ALTOSAAR
IMMERSION HEATERS

2,727,979

Filed Jan. 6, 1953

3 Sheets-Sheet 2

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

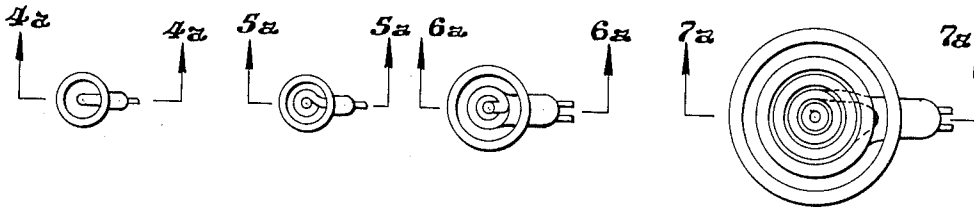
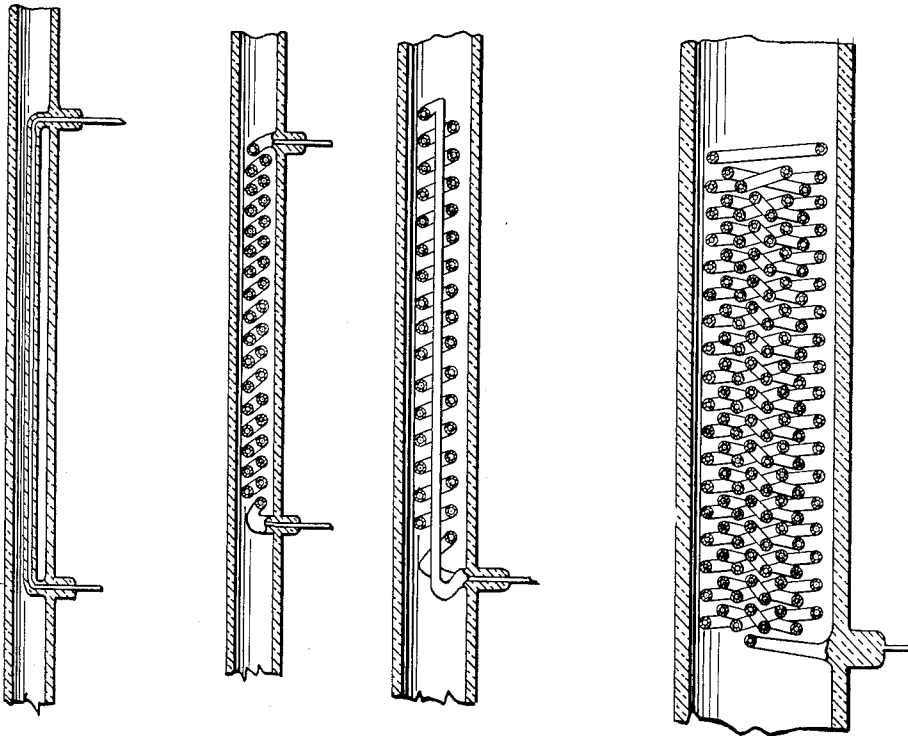


FIG. 4A.

FIG. 5A. FIG. 6A.

FIG. 7A.



INVENTOR
HENAULD ALTOSAAR

BY

Alan A. Aulley

ATTORNEY

Dec. 20, 1955

H. ALTOSAAR
IMMERSION HEATERS

2,727,979

Filed Jan. 6, 1953

3 Sheets-Sheet 3

FIG. 8.

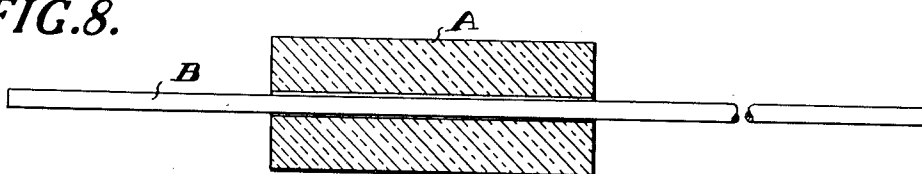


FIG. 9.

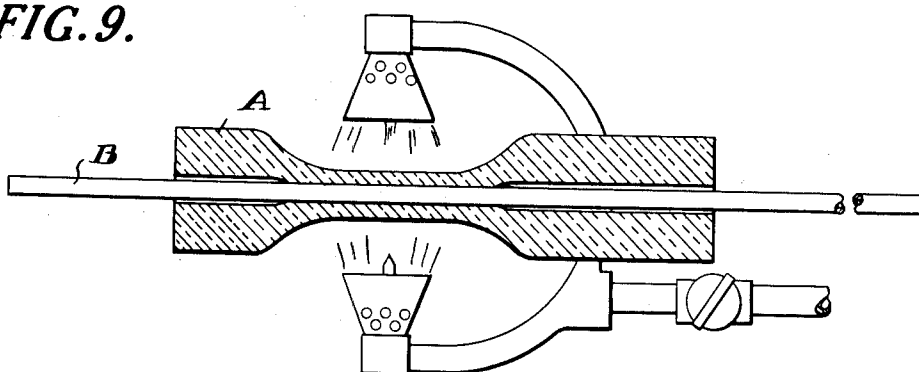
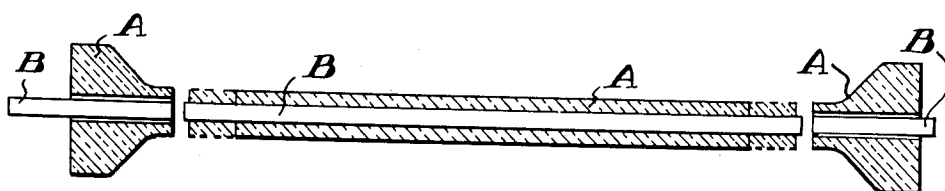


FIG. 10.

INVENTOR
HEINO ALTOSAAR

BY

Alan Swabey
ATTORNEY

1

2,727,979

IMMERSION HEATERS

Heino Altosaar, Magog, Quebec, Canada, assignor to Dominion Textile Company Limited, Montreal, Quebec, Canada, a corporation of Canada

Application January 6, 1953, Serial No. 329,815

13 Claims. (Cl. 219—41)

The present invention relates to the manufacture of electrical heating elements and more particularly to electrical resistance heating elements of the immersion type.

At the present time most of the immersion type electrical heaters utilizing a resistance element employ a coil of resistance wire wound about a mica or ceramic core which in turn is encased in a liquid-proof metal container.

While this form of construction is suitable for some purposes it presents certain disadvantages when used in laboratory apparatus or other places where the fluid to be heated contains chemicals which tend to corrode the outer casing. In many cases and particularly in laboratory work the size of the known prior art resistance type immersion heaters does not permit their incorporation directly into the apparatus. Further, due to the necessary layers of insulation and shielding materials to make these prior art resistance elements liquid-proof and insulated, a great deal of the heat generated by the resistance element is first dissipated by the surrounding materials and secondly is retained by these materials so that temperature control, especially within a critical range, is difficult.

The present invention aims to provide a method of making an electrical resistance heating element which is particularly adapted for use in an immersion type electrical heater suitable for laboratory or industrial use. The invention also provides preferred immersion heater constructions embodying resistance elements made in accordance with the present method.

Accordingly, the invention is an electrical resistance element adapted for use in an immersion type heater which is produced by means of the following steps. A length of metallic electrical resistance wire is threaded through a glass capillary of lesser length than the wire, the glass capillary is subjected to heat and is gradually and progressively drawn along the wire so as to reduce its diameter and to fuse the wire and glass capillary together.

The glass coated resistance wire so made can be shaped into any form of resistance element required by reheating the glass coating and forming it in the usual manner. As will be appreciated, the resistance wire used may be of any gauge so that the potential resistance of the element can be made to suit any desired application.

A preferred construction embodying a coated resistance wire made in accordance with the present invention includes an outside glass housing wherein there is mounted a double spiral coil heating element. In this construction the glass coated resistance wire is formed into a double coil so that two free ends of the wire extend from the same end of the coil. The housing is formed of glass so as to have one open end and one closed end with the free ends of the resistance wire extending through the closed end leaving the double spiral coil mounted concentrically of the housing. In this construction the glass coating of the free ends of the ele-

2

ment is fused directly into the closed end of the housing so that the entire housing may be immersed in a fluid solution without danger.

This construction can be varied in many ways, for example, in laboratory apparatus a length of glass coated resistance wire prepared in accordance with the present invention can be formed in a spiral coil or alternatively may be left in a straight section with turned out ends and can be incorporated in any portion of the glass tubing making up the apparatus where the application of heat is needed. This is accomplished by insertion of the glass coated resistance wire, in the required form, within the tubing with the free ends of the element extending through the side wall of the tube, the glass coating covering the wire being fused to the tubing at the exit point of the element ends.

The actual shapes or forms into which the coated resistance wire can be made are many and varied. Any desired length or multiplicity of coils can be made as required to give any desired heating action within a certain area. As an example, if it is desired to raise the temperature of a fluid passing through a glass tube forming a portion of a laboratory apparatus a certain number of degrees before passing onto the next portion of the apparatus, a heating element can be constructed in accordance with the invention embodying a known diameter of resistance wire and may be shaped into any form adaptable to the area through which the liquid must pass in order to give the desired heating surface for the approximate heat output required. Critical control of the heat output can be controlled by suitable instruments, for example, if the heater is employed in a constant flow set-up a suitable rheostat can be installed between the element and the power source, or if the flow of liquid treated is intermittent the heater may be controlled by a thermostat coupled arrangement.

Detailed description

Having thus generally described the nature of the invention particular reference will be made to the accompanying drawings showing by way of illustration immersion type heaters constructed as embodying resistance elements constructed in accordance with the present invention, and in which:

Figure 1 is a diagrammatic view partially in section of an immersion type heater having a double spiral coil resistance element.

Figure 2 is a cross sectional view of the construction shown in Figure 1 along the line 2—2.

Figure 3 is a longitudinal sectional view of a portion of the construction shown in Figure 1 along the line 3—3 of Figure 2.

Figure 4 is a view in plan of an alternative immersion type heater as it would appear when embodied in a portion of glass tubing forming part of a laboratory apparatus.

Figure 4a is a longitudinal cross section of the construction shown in Figure 4 along the line 4a—4a.

Figure 5 is a view in plan of a further alternative form of an immersion type heater embodying a spiral shaped resistance element in accordance with the invention as it would appear when embodied in a portion of glass tubing forming part of a laboratory apparatus.

Figure 5a is a longitudinal sectional view of the construction shown in Figure 5 along the line 5a—5a.

Figure 6 is a view in plan of a still further alternative construction of an immersion type heater embodying the combined straight and spiral type resistance element made in accordance with the invention as it would appear when embodied in a portion of glass tubing forming part of a laboratory apparatus.

Figure 6a is a longitudinal cross section of the construction shown in Figure 6 along the line 6a—6a.

Figure 7 is a view in plan of an immersion type heater embodying a multi-spiral coil of resistance element formed in accordance with the invention as it would appear when installed in a portion of glass tubing forming part of a laboratory apparatus.

Figure 7a is a longitudinal cross section of the construction shown in Figure 7:

Figure 8 is a diagrammatic view of the initial step in forming a resistance element in accordance with the present invention.

Figure 9 is a diagrammatic view corresponding to Figure 8 showing the next step of heating and drawing the glass capillary over the resistance wire.

Figure 10 is a diagrammatic view corresponding to Figure 9 showing the final step of removing the excess ends leaving the coated resistance wire in condition for use as a resistance heater element.

In accordance with the invention a length of metallic electrical resistance wire is threaded through a glass capillary of lesser length than the wire, the glass capillary is subjected to heat and while being heated is gradually and progressively drawn along the wire so as to reduce its diameter and to fuse the wire and glass capillary together.

The drawing of the glass capillary over the wire is performed from one end as the capillary is subjected to the softening heat so that as the drawing action takes place, reducing the diameter and lengthening the glass capillary over the wire, any air contained between the inner wall of the capillary and the wire is expelled ensuring an air free bond between the wire and the capillary. The capillary is heated during this drawing step until it is sufficiently softened to allow the drawing but not to a point where the material of the capillary flows. In other words, tension must be applied to the end of the capillary during the reducing operation so that in effect the inside bore of the capillary is reduced gradually and progressively along the length of the wire so as to squeeze out the air through the undrawn bore of the remainder of the capillary.

These steps are shown diagrammatically and in sequence in Figures 8 through 10 of the accompanying drawings wherein in Figure 8 the glass capillary indicated as "A" is threaded over a length of resistance wire "B." The wire and capillary can be of any length that can be conveniently handled with the wire at all times being of considerably greater length than the initial length of the capillary.

With particular reference to the accompanying drawings one preferred construction of an immersion type heater is shown by way of example in Figures 1, 2 and 3. This construction consists of an outside glass shield or housing 10 wherein there is mounted a double coil of glass coated resistance wire 12 made in accordance with the invention. The resistance wire or filament 12 is made up of a metallic resistance wire 14 which is completely surrounded by a glass coating 16, see Figure 3.

In the construction shown, the filament 12 is sealed off from the main body 10 of the housing by a partition 18 and the connections from an electric conduit 20 are also sealed at the entry point in an extension 22 which forms a continuation of the housing 10 and extends above the partition 18. Between the ends of the element wire 12 and the connections 19 from the electrical conduit there is provided short lengths of heavier resistance wire 13 to prevent fusing of the ends of the element wire 12 as they pass through the partition 18. Suitable ceramic insulators 21 are provided adjacent the connection of the resistance and power source wires. With this arrangement, the entire heater including a portion of the electric conduit 20, which is preferably of the rubber covered variety, can be immersed in a liquid without damage.

As will be appreciated, the glass coating 16 on the resistance wire 14 lends itself to any applications, for example, as is shown in Figures 4 through 7, similar

heating elements can be placed in the flowline of a laboratory apparatus so that liquid is heated as it passed through the line. As the gauge of the wire can be varied to give practically any resistance required and the amount of heating element can also be varied to give the heating surface and power consumption required, the present liquid heating arrangement can be adapted to suit practically any needs.

The glass capillary used for the coating of the resistance wire is preferably of borosilicate type glass, for example, that known by the tradename of "Pyrex" glass. This glass is more resistant to mechanical shock, to cracking due to sudden temperature changes, and to the solvent action of water, acids and alkalis. It does however, require higher temperatures for softening and working and consequently a pressure flame of greater intensity than the usual Bunsen burner flame must be utilized.

For example, it has been found that "Pyrex" tubes or capillaries having external diameters of from about 5 mm. to about 10 mm. can be successfully drawn in accordance with the invention when subjected to temperatures of from about 800° C. to about 1000° C.

When forming the resistance wire into coils or other forms after it has been coated it has been found that a heating temperature from about 600° C. to about 700° C. is sufficient.

As will be appreciated, the present method of making a resistance element and the resistance heaters constructed with this element presents distinct advantages over the prior art devices of this nature. For example, the present element has a very low specific heat, which prevents overshooting of a desired degree of temperature. It has a very large heating surface in comparison with its actual volume. For example, a heater element may be constructed in accordance with the invention having a size or volume accommodated in 1 cubic inch which has a heating surface of 120 sq. inches. This feature allows for the making of heating elements having a low local heat output which is particularly advantageous in laboratory work with decomposable solutions. The small volume or size in which the heater can be made and the light weight of the resistance element permits it to be incorporated in many embodiments impossible with standard heater constructions.

The glass coating of the element and the absence of any metallic housing makes a resistance heater constructed in accordance with the invention practically corrosion resistant except for hydrofluoric acid and concentrated sodium and potassium hydroxide.

By way of an example it has been found on experiment that an 18" length of 34 gauge chromel A resistance wire embedded in a "Pyrex" coating and drawn to a condition where the thickness of the coated element is substantially 0.7 mm. when subjected to a current flow of 110 v. gives the following results.

Heating capacity-----	493 watts.
Weight-----	approx. 0.4 g.
Heating surface-----	approx. 10 cm. ² .
Volume of the element-----	approx. 0.085 cm. ³ .
Specific heat-----	0.08 cal/°C.

As previously recited the resistance wire employed may be of any gauge and the thickness of the glass coating will at all times be proportionate to the gauge of resistance wire employed so that elements may be made in accordance with the present invention to suit any requirement with regard to heat output required and available space to accommodate the heating element.

I claim:

1. An electrical immersion type heater comprising an elongated heating resistance wire having a fluid-proof glass coating of cylindrical formation with said resistance extending axially therethrough, said coated resistance wire being formed so as to have two free ends and being mounted within a glass housing having openings adapted

5

to allow for passage of fluid therethrough, the major portion of said coated wire between said free ends being wholly enclosed within said housing with the terminal portions of said free ends extending beyond said housing, the juncture of said glass coating of said resistance wire and said housing being sealed to each other to prevent liquid from passing therethrough.

2. An electrical immersion type heater as claimed in claim 1 wherein said elongated glass coated resistance wire is formed into a double spiral with the two free ends extending from said spiral at the same end and in juxtaposed relationship, said housing having an open end and a closed end with said element free ends passing through said closed end.

3. An electrical immersion type heater as claimed in claim 2 wherein said housing includes an extension constituting a chamber extending beyond said closed end, said chamber including an opening, an electrical conduit means extending within said chamber through said opening to a connection with the free ends of the resistance wire extending therein, and said housing chamber is sealed about said electrical conduit at the entrance point thereof.

4. An electrical immersion type resistance heater as claimed in claim 1 wherein said coated electrical resistance wire is formed so as to have a straight major portion with the free end portions bent outwards from said major portions, and said housing comprises of a length of cylindrical glass tubing with said coated resistance wire end portions extending through the side walls of said tubing and being sealed thereto.

5. An electrical immersion type heater as claimed in claim 1, wherein said coated resistance wire is formed in the shape of a single spiral coil having the free ends extending transaxially from opposite ends of coil, said housing comprising of a portion of a cylindrical glass tubing with said coated resistance wire free ends extending through a side wall of said tube and being sealed thereto.

6. An electrical immersion type resistance heater as claimed in claim 1 wherein said coated resistance wire is formed so as to have a first straight portion and a spiral coil formed about said straight portion with the free ends of said coated wire both terminating at one end and extending transaxially from said straight portion and spiral coil in juxtaposed relationship, said housing comprising a portion of cylindrical glass tubing, with said coated resistance wire free ends extending through a side wall of said tube end being sealed thereto.

7. An electrical immersion type heater as claimed in claim 1 wherein said coated resistance wire is formed into a multi-spiral arrangement of gradually increasing diameter with the spirals being arranged concentrically of each other with the free ends of said coated resistance wire emerging from one end of said spirals in juxtaposed relationship with each other, said housing comprising a portion of cylindrical glass tubing with the free ends of said coated resistance wire extending through a side wall of said tubing and being sealed thereto.

8. A method of forming an insulated electric current conducting wire unit, comprising, the steps of threading a length of metallic wire through a glass capillary of considerable lesser length than said wire, heating and grad-

6

ually and progressively attenuating said glass capillary over said wire to increase the length of said capillary while decreasing the diameter of said capillary only without deformation of said metallic wire.

9. A method of forming an insulated wire as claimed in claim 8, wherein said heating and attenuating step is initially performed at one end of said capillary and said attenuating action takes place in one direction away from the unattenuated end.

10. An electrical immersion-type heater comprising of elongated heating resistance wire having a fluid-proof glass coating, said elongated glass coated resistance wire being formed into a double spiral with the two free ends extending from said spiral at the same end in juxtaposed relationship, said coated resistance wire being mounted within a glass housing having openings adapted to allow for passage of fluid therethrough, said housing having an open end and a closed end with said element free ends passing through said closed end, the major portion of said coated wire between said free ends being wholly enclosed within said housing.

11. An electrical immersion type heater as claimed in claim 10, wherein said housing includes extension constituting a chamber extending beyond said closed end, said chamber including an opening, an electrical conduit means extending within said chamber through said opening to a connection with the free ends of the resistance wires extending therein, and said housing chamber is sealed about said electrical conduit at the entrance point thereof.

12. An electrical immersion type heater comprising of elongated heating resistance wire having a fluid-proof glass coating, said glass coated resistance wire being formed in the shape of a single spiral coil having the free ends extending transaxially from opposite ends of said coil, said coil being mounted within a glass housing having openings adapted to allow for passage of fluid therethrough, said housing comprising a portion of cylindrical glass tubing, with said coated resistance wire free ends extending through a side wall of said tube and being sealed thereto.

13. An electrical immersion type heater comprising an elongated heating resistance wire having a fluid-proof glass coating, said coated resistance wire being formed into a multi-spiral arrangement of gradually increasing diameter with the spirals being arranged concentrically of each other with the free ends of said coated resistance wire emerging from one end of said spirals in juxtaposed relationship with each other, said spirals being mounted within a glass housing having openings adapted to allow for passage of fluids therethrough, said housing comprising a portion of cylindrical glass tubing with the free ends of said coated resistance wire extending through a side wall of said tubing and being sealed thereto.

References Cited in the file of this patent

UNITED STATES PATENTS

1,334,850	George et al. -----	Mar. 23, 1920
1,365,978	Gallager -----	Jan. 18, 1921
1,574,581	Kay -----	Feb. 23, 1926
2,414,499	Webber -----	Jan. 21, 1947