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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to the Heat Sealing of Glass to a Body

We, WESTERN ELECTRIC COMPANY, INCORPORATED, of 195 Broadway, New York City, New York State, United States of America, a Corporation organized and existing under the laws of the State of New York, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to methods of heat sealing glass, or thermoplastic material, which are substantially transparent to radiant energy, to the surface of a body, using radiant energy to provide necessary heat for accomplishing sealing.

In heat sealing glass to a surface of a body, it is necessary to bring the temperature of the glass and the surface of the body to the requisite sealing temperature, usually the temperature at which the glass noticeably softens and wets the surface to which it is to be sealed. In the past, this has been accomplished in various ways including exposing both the glass and the body to infrared radiation until the surfaces to be sealed together reach the sealing temperature. For many applications, this is a satisfactory approach. In other applications, this has not proved satisfactory because the application of radiant energy to both the glass and the body for a sufficient period to heat both to the sealing temperature has had deleterious effects on the body. For example, in encapsulating deposited carbon resistors in glass using infrared radiation as the heat source, the prolonged exposure of the resistor to infrared radiation and resulting heating adversely affects the electrical properties of the carbon resistance film.

[Price 4s. 6d.]

Further, the welded junctions of the resistor's end caps and leads become brittle.

According to the present invention there is provided a method of heat sealing glass or thermoplastic material to a body, by means of radiant energy projected through the glass or thermoplastic material, the glass or thermoplastic material in its normal state being substantially transparent to said radiant energy, in which at least a portion of the glass or thermoplastic material through which the radiant energy is projected has incorporated therein material adapted to absorb said radiant energy in an amount such that the radiant energy absorbed by the glass or thermoplastic material is increased to obtain a desired distribution of radiant energy between the body and the glass or thermoplastic material.

The invention has special utility for the encapsulation of electrical components in a glass. Thus glass tinted with a predetermined quantity of radiant energy absorbing material is placed in contact with a body to which it is to be sealed. For example, the body may be the metallic end cap of an electrical component, and the tinted glass may be in the form of a sleeve suitable for encapsulating the component. The glass is exposed to a source of radiant energy, particularly a source of infrared energy, so that rays from the source project through the glass and impinge upon the body. The energy which falls upon the glass is distributed between the glass and the body in accordance with the filtering action provided by the tinting in the glass to effect a heat seal between the glass and the body. This distribution of energy may be controlled by varying the quantity of radiant energy absorbing material which is added to the glass.

Price 5s. 0d.

The invention will now be described with reference to the accompanying drawing, in which:

FIG. 1 illustrates an electrical component placed within a tinted glass sleeve in preparation for encapsulation;

FIG. 2 schematically illustrates radiant energy apparatus suitable for heat sealing the component and glass sleeve shown in FIG. 1; and

FIG. 3 is an enlarged view taken along line 3—3 of FIG. 2 illustrating the action of the tinted glass sleeve in distributing radiant energy between the glass and a component to which the glass is to be sealed.

Referring to FIG. 1, an electrical component, shown by way of example as a deposited carbon resistor 20, is placed within a cylindrical glass sleeve 21 in preparation for encapsulation. Resistor 20 includes a ceramic core 23 having a deposited carbon resistance film 24 thereon in which a helical groove has been cut. A pair of terminations 25 and 26 of sputtered gold make contact with resistance film 24. A pair of conductive metallic end caps 28 and 29 are force fitted onto the ends of the core in contact with the terminations. A pair of leads 31 and 32 are fixed by welds 34 and 35 to caps 28 and 29, respectively.

Caps 28 and 29 are identical and include a hollow core gripping portion 41 having an internal diameter dimension a opening into a flared lip 42 of diameter dimension b substantially to the inside diameter of sleeve 21. Portion 41 terminates in a hollow cylinder 43 having an internal diameter dimension c and an end wall 44. The length of portion 41 is represented by dimension d ; the length of cylinder 43 by dimension e ; and the thickness of the cap by dimension f .

Sleeve 21 is formed of glass tinted with a predetermined amount of an infrared absorptive material. However, if sleeve 21 is formed of clear, untinted, glass and is sought to heat seal the sleeve to cap 28 using infrared energy, it has been found necessary to subject the areas of the glass and cap to be sealed together to the radiation for a prolonged period until both surfaces to be sealed are heated to the sealing temperature. Since infrared radiation readily passes through clear glass, the cap is heated for an appreciable period before the glass itself is raised to the sealing temperature. It has been found that such prolonged heating of a deposited carbon resistor 20 results in deleterious agglomeration of the gold terminations 25 and 26, degradation of resistance film 24, and making brittle the welds 34 and 35.

If sleeve 21 were formed of glass substantially opaque and impervious to infrared radiation, such exposure to infrared radiation would immediately heat the glass. However, it has been found that so much of the radiation is absorbed by such glass that the end

cap remains unheated for an unacceptably long period.

The term "tint" as used herein contemplates an addition to the glass of a radiant energy absorbing material in an amount sufficient to absorb an appreciable amount of the radiant energy employed, but not in an amount sufficient to render the glass substantially opaque to such radiation. "Tinted" glass is, therefore, neither clear nor opaque in the context discussed above.

The ability of sleeve 21 to absorb radiant energy and heat itself, and the ability of sleeve 21 to transmit radiation to the surface to which it is to be sealed, is controlled by tinting the glass with a predetermined quantity of radiant energy absorptive material. Assuming that infrared radiation is to be employed, iron oxide (ferric oxide, ferrous oxide, or mixtures of these oxides) is a particularly effective absorptive material. However, a variety of additives are known to increase the infrared absorption of glass and could be employed for this purpose, for example cobalt oxide.

Generalizing, there may be used any material which when added to glass increases its ability to absorb the radiant energy to be employed in sealing. If infrared radiation is to be employed, any additive which effectively absorbs radiation in the wave lengths above $2,000\text{\AA}$, and especially between $8,000\text{\AA}$ and $12,000\text{\AA}$, may be used. Those skilled in this art may readily select a tinting material once the glass and source of radiant energy have been selected.

The amount of such material added to the glass of sleeve 21 will depend upon the desired distribution of energy between the glass and the body, cap 28, to which it is to be sealed. The desired distribution of energy between the glass and the body will, in turn, depend upon the desired degree of heating which is to be imparted to each.

For example, assume a component, such as resistor 20 which cannot withstand prolonged intensive exposure to radiation and heating, is to be encapsulated in glass. The minimum total exposure of the resistor to heating radiation consistent with bringing the surface to be sealed to the sealing temperature is desirable. The desired distribution of energy is between the glass and the surface to which it is to be sealed will depend upon the relative heat capacities of the glass and the resistor, the relative abilities of the glass and the resistor to reflect and to reradiate, and the ability of the glass to distribute energy between itself and the resistor. As will be apparent to those familiar with this art, the heat capacity of the resistor and its ability to reflect and reradiate depend upon the materials of which it is made, its mass, shape, dimensions, and surface conditions. The same is true of the glass. The heat capacity and ability to reflect and reradiate of the resistor

and the glass may be calculated or determined empirically. The term "heat capacity" as used hereinafter is intended to encompass heat capacity as well as capacity to reflect and reradiate.

In this example, radiant energy absorptive material is added to the glass so that the total radiant energy which falls upon the glass is distributed between the glass and the resistor in precisely the right proportions to bring the glass and the surfaces to which it is to be sealed to the sealing temperature substantially simultaneously. Total exposure time to radiation is thereby minimized along with the possibility of deleterious effects upon the resistor.

If only a portion of the glass is exposed to radiant energy, then the tinting may be confined to this portion of the glass.

Referring to FIG. 2, the heat sealing apparatus may include a conventional radiant energy furnace 50 having a highly reflective, elliptical internal wall 51, the foci of which are at points 52 and 53. A source of infrared radiation, lamp 56, is positioned so that its filament 57 is centered about focus 52. Leads 58 connect the filament to a suitable electrical power source 59 and the burning time of the lamp is controllable by a timer 60.

A pedestal 61 is provided with an axial bore 62 (FIGS. 2 and 3) having a diameter slightly larger than the outside diameter of a sleeve 21. A second axial bore 63 of a diameter sufficiently large to accommodate a lead such as lead 31 communicates with bore 62. The depth of bore 62 is such as to support sleeve 21 so that all but a predetermined portion of the sleeve is masked against radiation by the walls of pedestal 61. The depth of bore 63 is such as to support the resistor in the desired position within sleeve 21. This position is illustrated in FIGS. 1 and 3.

It may be desirable to provide for adjustment of the sleeve and resistor relative to focus 53 of the furnace. This is accomplished by providing pedestal 61 with a rack 71 which engages a pinion 72. The pinion may be rotated and the position of pedestal 61 adjusted by rotating a handle 73 fixed on a shaft 74 along with the pinion.

In operation, a resistor 20 is placed within a sleeve 21 and the sleeve is inserted within bore 62 to assume the position best illustrated in FIG. 3. The sleeve is supported on the bottom surface of bore 62 while lead 31 is accommodated within bore 63 and supports the resistor in the desired position. Handle 73 is turned to adjust the position of the sleeve and resistor relative to focus 53. Power source 59 is activated to heat filament 57 for a desired period as controlled by timer 60. As is known, energy originating at one focus of an elliptical furnace is caused to concentrate at the other focus, in this instance focus 53. As seen in FIG. 3, unmasked portions of

sleeve 21 are directly exposed to infrared radiation. A portion of the radiation (indicated by arrows 81, FIG. 3) which falls upon the sleeve is arrested by the sleeve causing it to become heated. The unarrested portion of this radiation passes through the sleeve to heat the end cap 29. Since the sleeve 21 has been tinted, as discussed above, the internal walls of the sleeve and the external surface of the cap reach the sealing temperature substantially simultaneously and a partial encapsulation results.

The specific examples set out below should provide further insight into the practice of the above-described method using the above discussed apparatus.

EXAMPLE I

End Cap 28

Material—Alloy comprising approximately 28% Nickel, 18% Cobalt, 53% Iron available under the trade names "Kovar" "Fornico" and "Rodar".

Dimensions—
a .061 inches
b .093 inches
c .050 inches
d .040 inches
e .040 inches
f .012 inches

Core 23

Material—Alkaline earth porcelain with thin coating of pyrolytic carbon thereon having terminations of sputtered gold.

Dimensions—Diameter .062 inches
Length .300 inches

Lead 31

Material—nickel

Dimensions—diameter .025 inches
length 1.625 inches

Glass Sleeve 21

Material—
SiO₂ 67.3%,
Na₂O 4.6%,
K₂O 1.0%,
MgO 0.2%,
B₂O₃ 24.6%,
Al₂O₃ 1.7%.

Dimensions—length .360 inches
inside diameter .095 inches
wall thickness .015 inches.

Radiant Energy Absorptive Material

Material—Iron oxide 3½% by weight of the glass.

Heat Cycle

lamp, 600-watt, quartz-iodine incandescent bulb

exposure time 3½ seconds

power source 96 volts AC

dimensions of furnace—ellipsoid 8" in diameter in largest circular plane and 1.633 inches between foci

exposure of sleeve above mask—.125 inches.

EXAMPLE II

5 All factors remain the same as in Example I excepting that the percentage of iron oxide added to the glass is reduced to 1½%. Satisfactory sealing is achieved.

EXAMPLE III

10 All factors remain the same as in Example I excepting that the percentage of iron oxide content of the glass is changed to 4%. Satisfactory sealing is achieved.

EXAMPLE IV

15 All factors remain the same as in Example I excepting that the iron oxide content of the glass is substantially below 1½% and the heat cycle is prolonged to achieve heat sealing. The resistor is over-heated and deleterious effects appear thereon due to the prolonged heating necessary to bring the glass to the sealing temperature.

EXAMPLE V

25 All factors and dimensions remain the same as in Example I excepting that the iron oxide content of the glass sleeve 21 is raised substantially above 4%. Unsatisfactory sealing is achieved due to insufficient heating of the end cap accompanied by excessive softening of the glass sleeve.

30 In the above discussed examples of this method, it has been assumed desirable to raise the glass and the body which it is to be sealed to the sealing temperature simultaneously and in a minimum of time. While this will often be a desirable end in processes such as encapsulation of electric components in glass, there are other instances in which it may be desirable to bring the two surfaces to the sealing temperature at different times separated by a predetermined interval. This may be conveniently accomplished by an appropriate increase or decrease in the amount of radiant energy absorptive material added to the glass of sleeve 21.

45 While the invention has been described in connection with specific problems of encapsulating electrical components, it may be generally applied to heat sealing silica glass, or other materials, particularly thermoplastics, not opaque to radiant energy, to a variety of surfaces.

WHAT WE CLAIM IS:—

55 1. A method of heat sealing glass or thermoplastic material to a body, by means of radiant energy projected through the glass or thermoplastic material, the glass or thermo-

plastic material in its normal state being substantially transparent to said radiant energy, in which at least a portion of the glass or thermoplastic material through which the radiant energy is projected has incorporated therein material adapted to absorb said radiant energy in an amount such that the radiant energy absorbed by the glass or thermoplastic material is increased to obtain a desired distribution of radiant energy between the body and the glass or thermoplastic material.

2. A method according to claim 1, in which portions of the glass or thermoplastic material and the body which are not required to be sealed are selectively masked against said radiant energy.

3. A method according to claim 1 or 2; in which said radiant energy consists of infrared energy, and said absorptive material absorbs radiation in the wave lengths between 8,000Å and 12,000Å.

4. A method according to claim 3, in which said glass is borosilicate glass and said radiant energy absorbing material comprises iron oxide.

5. A method according to claim 4, in which the weight of iron oxide added to the glass is from 1½ percent to four percent of the weight of the glass.

6. A method according to any one of the preceding claims, in which said glass or thermoplastic material comprises a sleeve within which said body is placed for encapsulation.

7. A method according to claim 6, in which said body comprises a deposited carbon resistor having end caps, said sleeve being heat sealed to said end caps.

8. A method according to claim 7, as dependent upon claim 2, in which said sleeve having said resistor therein is placed within a member having an axial bore of diameter slightly larger than the outside diameter of said sleeve, one end cap of said resistor and one end of said sleeve extending beyond the member so as to be positioned at a focus of infrared radiation within a furnace.

9. A method of heat sealing glass to a body substantially as herein described with reference to the accompanying drawings.

10. An element comprising glass heat sealed to a body prepared by a method according to any one of the preceding claims.

H. L. JACKSON,
Chartered Patent Agent,
5, Mornington Road,
Woodford Green, Essex,
Agent for the Applicants.

exposure of sleeve above mask—.125 inches.

EXAMPLE II

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EXAMPLE III

10 All factors remain the same as in Example I excepting that the percentage of iron oxide content of the glass is changed to 4%. Satisfactory sealing is achieved.

EXAMPLE IV

15 All factors remain the same as in Example I excepting that the iron oxide content of the glass is substantially below 1½% and the heat cycle is prolonged to achieve heat sealing. The resistor is over-heated and deleterious effects appear thereon due to the prolonged heating necessary to bring the glass to the sealing temperature.

EXAMPLE V

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30 In the above discussed examples of this method, it has been assumed desirable to raise the glass and the body which it is to be sealed to the sealing temperature simultaneously and in a minimum of time. While this will often be a desirable end in processes such as encapsulation of electric components in glass, there are other instances in which it may be desirable to bring the two surfaces to the sealing temperature at different times separated by a predetermined interval. This

35 may be conveniently accomplished by an appropriate increase or decrease in the amount of radiant energy absorptive material added to the glass of sleeve 21.

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45 surfaces.

WHAT WE CLAIM IS:—

1. A method of heat sealing glass or thermoplastic material to a body, by means of radiant energy projected through the glass

55 or thermoplastic material, the glass or thermo-

plastic material in its normal state being substantially transparent to said radiant energy, in which at least a portion of the glass or thermoplastic material through which the radiant energy is projected has incorporated therein material adapted to absorb said radiant energy in an amount such that the radiant energy absorbed by the glass or thermoplastic material is increased to obtain a desired distribution of radiant energy between the body and the glass or thermoplastic material.

2. A method according to claim 1, in which portions of the glass or thermoplastic material and the body which are not required to be sealed are selectively masked against said radiant energy.

3. A method according to claim 1 or 2; in which said radiant energy consists of infrared energy, and said absorptive material absorbs radiation in the wave lengths between 8,000Å and 12,000Å.

4. A method according to claim 3, in which said glass is borosilicate glass and said radiant energy absorbing material comprises iron oxide.

5. A method according to claim 4, in which the weight of iron oxide added to the glass is from 1½ percent to four percent of the weight of the glass.

6. A method according to any one of the preceding claims, in which said glass or thermoplastic material comprises a sleeve within which said body is placed for encapsulation.

7. A method according to claim 6, in which said body comprises a deposited carbon resistor having end caps, said sleeve being heat sealed to said end caps.

8. A method according to claim 7, as dependent upon claim 2, in which said sleeve having said resistor therein is placed within a member having an axial bore of diameter slightly larger than the outside diameter of said sleeve, one end cap of said resistor and one end of said sleeve extending beyond the member so as to be positioned at a focus of infrared radiation within a furnace.

9. A method of heat sealing glass to a body substantially as herein described with reference to the accompanying drawings.

10. An element comprising glass heat sealed to a body prepared by a method according to any one of the preceding claims.

H. L. JACKSON,
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5, Mornington Road,
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