Oct. 31, 1939. W. M. CLARK ET AL 2,178,419

METHOD AND APPARATUS FOR COATING VITREOUS TUBES

Filed Dec. 11, 1936

Fig. 1.

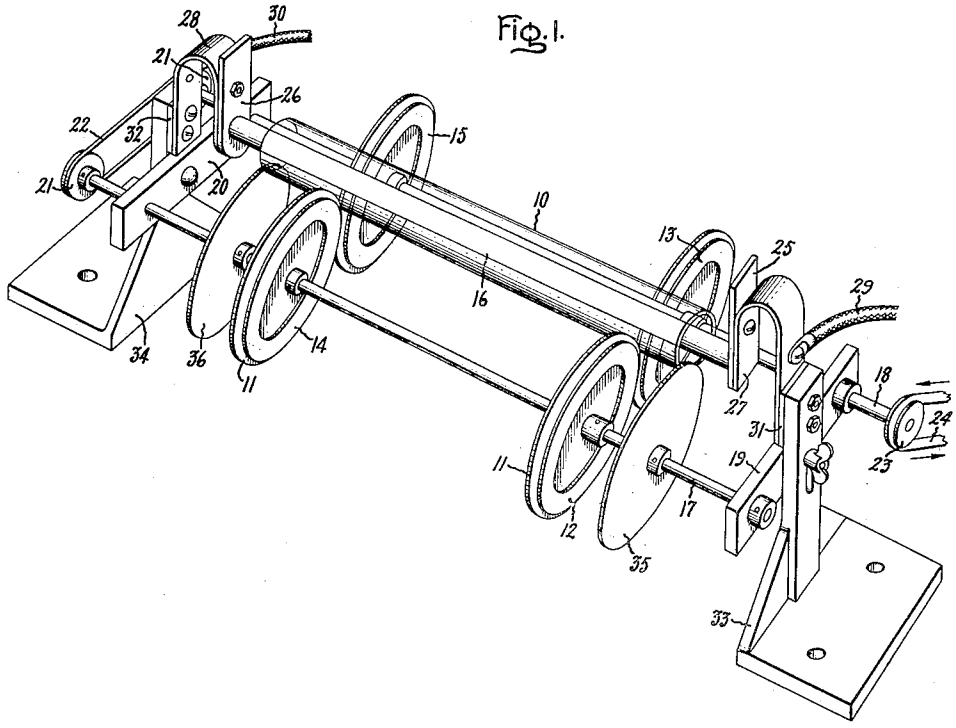
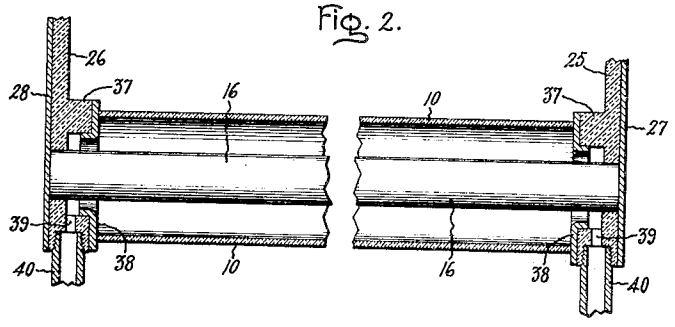


Fig. 2.



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Patented Oct. 31, 1939

2,178,419

UNITED STATES PATENT OFFICE

2,178,419

METHOD AND APPARATUS FOR COATING VITREOUS TUBES

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Application December 11, 1936, Serial No. 115,402

7 Claims. (Cl. 219—19)

Our invention relates to a method of and apparatus for coating vitreous tubing and more particularly to a method and apparatus for applying coatings of an enamel or glaze to the inner surfaces of glass tubes used, for example, as containers or envelopes for electric lamps.

Heretofore it has been the practice to place the coated glass tubes in an oven maintained at the required temperature to fuse the coating. Compared to the method and apparatus comprising our invention, this method is very inefficient due to loss of heat from the greater area exposed and to the greater time required for the heat to "soak" through the glass tube to the coating. Oven heating is also disadvantageous where the heating takes place in an evacuated space or in a space filled with a gas which facilitates the treatment of the coating due to its large size and the likelihood of contaminating the gas.

According to our invention, the internally coated vitreous tubes are heated by means of an elongated heating element, preferably an electrical resistance element, extending through the interior thereof. The tube is preferably rotated about its longitudinal axis to more evenly distribute the heat and it may be closed at the ends so that the interior may be treated by a gas if desired. In this manner the coating on the inner surface can be brought to a high temperature before the walls of the tubular body reach the softening point. Where a gaseous atmosphere for treating the coating is to be employed, the gas is introduced and exhausted through the end closures which also provide means for supporting the heating unit and conducting the electrical energy thereto. Other features and advantages of our invention will appear from the following detailed description and from the accompanying drawing.

In the drawing, Fig. 1 is a perspective view of apparatus comprising our invention, and Fig. 2 is a sectional view of a modified portion thereof.

Referring to Fig. 1, the glass tube 10 which is to be treated is supported on facings 11 of pairs of rollers 12, 13 and 14, 15 which hold said tube 10 in a position surrounding a heater element 16 which extends therethrough. The facings 11 of the rollers 12, 13, 14 and 15 are preferably made from asbestos so as not to unduly chill the glass tube 10 and so as to engage said tube 10 with sufficient friction to cause it to rotate as rollers 12, 13, 14 and 15 are rotated. Rollers 12 and 14 are mounted on a shaft 17, and rollers 13 and 15 are mounted on the shaft 18. The shafts 17 and 18 are supported by bars 19 and 20 and are rotated in unison through pulleys 21 which are coupled by a belt 22. The shafts 17 and 18 are driven through a pulley 23 on shaft 18 by a belt 24 which is connected to a source of power not shown. The rotation of the glass tube 10 causes the heat from the element 16 to be evenly distributed circumferentially about the said tube.

The heating element 16 may be a "Globar" rod in which the actual electrical resistance member is enclosed for protection and support. However, other types of heating units which are self-supporting and have the electrical terminals therefor at the ends may be used. The end portions of the heater 16 fit into apertures in blocks 25 and 26 and abut against resilient U-shaped metal strips or springs 27 and 28, which also serve as electrical connections thereto. The heat from the element 16 is shielded from the springs 27 and 28 by the blocks 25 and 26 respectively, which are preferably made of asbestos and are attached to said springs 27 and 28. The electrical energy required for the heating element 16 is conducted to the springs 27 and 28 from a source not shown, by cables 29 and 30, and is insulated from the rest of the apparatus by insulating plates 31 and 32, which separate the springs 27 and 28 from their respective supporting standards 33 and 34. The bars 19 and 20 are also attached to the standards 33 and 34 and may be adjusted vertically thereon to locate the heating element 16 in the desired position within the glass tube 10.

The glass tube 10 is prevented from shifting longitudinally by a pair of discs 35 and 36 which are somewhat larger than rollers 12 and 14 and are mounted on shaft 17 at points adjacent to the ends of said tube 10.

Although the specific heating element 16 shown gives off substantially a uniform amount of heat from end to end, it may be desirable to compensate for or prevent the escape of heat from the open ends of the glass tube 10 in order to treat said tube evenly from end to end. In order to compensate for the loss of heat, the heating element 16 is preferably constructed so as to have a greater heating capacity from the center outward toward the ends. To prevent the escape of heat from the open ends of the tube 10, the said ends may be closed off as shown in the modification in Fig. 2. In the modification, the blocks 25 and 26 are both provided with bosses 37 which carry flanged washers 38, which in turn engage the ends of the glass tube 10. The washers 38 turn with the tube 10 and effectively close off the ends thereof. Each of the bosses 37 is also provided with an aperture 39 which permits changing the atmosphere within the said tube 10. Because of the cooling effect of the bosses 37 and washers 38 on the tube 10, it may be desirable to construct the heating element 16 so that the ends are kept at a higher temperature than the center, in order to bring the said tube 10 to substantially the same temperature from end to end. The apertures 39 in the bosses 37 permit exhausting the interior of the tubular body 10 or filling the interior with a gas inert to the inner surface, or

a gas capable of combining with or otherwise treating said inner surface. If a gas is to be introduced into the interior of the tube 10, it may be passed in through one pipe 40 and withdrawn through the other pipe 40.

The glass tube to be coated or enameled may be smooth on the inside or may be given an etch similar to the etch developed on the inside of acid frosted incandescent lamp bulbs. The material to be coated on the inside of the tube may be a solid held in suspension in a liquid and sprayed on the inside surface, or some liquid saturated with a soluble material may be sprayed on or applied by dipping or flowing on the inside surface. The object is to coat the inside of the tube with a layer of the material to be burned on by the application of heat. If a transparent glaze is to be developed, the softening temperature of the coating material must be less than the softening temperature of the glass tube. An opaque or translucent coating, either colored or colorless, may be applied also. Such a coating should contain some ingredient of relatively low softening point to act as a binder.

The glass tube 10, either smooth or etched, is coated on the inside with a uniform layer of the coating or enameling mixture. The coated tube is placed on the rotating device and the heating element put in position. The rotating device is started so as to revolve the tube at about 25 R. P. M. and the coating is dried out by slowly heating the glass tube by means of a controlled current through the heating element 16. When the coating has been thoroughly baked out at a relatively low temperature, the current through the heating element is gradually increased until the softening temperature of the glass tube is approached. The tube is then maintained at this relatively high temperature until the coating matures. In the case of transparent enamels melting and flowing will occur. The operation is completed when the enamel layer has assumed a smooth and uniform texture. When an opacifying agent has been included in the coating mixture the resulting enamel is opaque or translucent. In this case the tube is heated at a relatively high temperature until the binding material has softened sufficiently to hold the coating mixture in intimate contact with the inside surface of the tube.

We have discovered that, by use of the method and the apparatus described above, it is possible to coat a "Pyrex" tube on the inside with a thick or a thin layer of fused sodium borate. The "Pyrex" tube is first etched. A saturated solution of sodium borate in water is then introduced. The etch will hold an appreciable quantity of the solution and the excess is drained off. The tube is then heated according to the procedure described above.

Another particular application of this method is the coating of an etched "Pyrex" tube with an enamel of the following composition: $3B_2O_3$, $2SeO_2$, $1/8NaNO_3$ (molecular proportions). This enamel dissolves in water and the tube is coated with a saturated solution of this mixture into which some very fine ground solid material of the same composition has been introduced. The application of this selenium borate mixture to the inside of an etched "Pyrex" tube develops a semi-transparent surface on heating. The surface layer seems to be continuous and does not exhibit checks or cracks.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. Apparatus for heating the inner surface of a vitreous tube comprising an elongated electrical resistance heating element with supporting means therefor, means for supporting said tube independently of the heating element in a position surrounding said heating element and spaced therefrom and means for rotating said tube about its longitudinal axis.

2. Apparatus for heating the inner surface of a vitreous tube comprising an elongated electrical heating elements with supporting means therefor and means for supporting said tube independently of the heating element in a position surrounding said heating element, said heating element having greater heating effect at the ends than at the middle.

3. Apparatus for heating the inner surface of a vitreous tube comprising an elongated electrical heating element with supporting means therefor, means for supporting said tube independently of the heating element in a position surrounding said heating element, means for closing off the ends of said tube to retain the heat therein, and means for rotating said tube about its longitudinal axis.

4. Apparatus for heating the inner surface of a vitreous tube comprising an elongated electrical heating element with supporting means therefor, means for supporting said tube independently of the heating element in a position surrounding said heating element, means for closing off the ends of said tube from the atmosphere, said last-named means having apertures therethrough for permitting a gas to be passed through said tube during the heating thereof, and means for rotating said tube about its longitudinal axis.

5. The method of coating a vitreous tube which comprises applying a layer of an enameling mixture to the inner surface of said tube, placing said tube around and spaced from an elongated heating element, and rotating said tube about its longitudinal axis during the heating of said enameling mixture.

6. The method of coating a vitreous tube which comprises applying a layer of an enameling mixture to the inner surface of said tube, placing said tube around and spaced from an elongated heating element and holding it in a substantially horizontal position, and rotating said tube about its longitudinal axis during the heating of said enameling mixture.

7. The method of coating a vitreous tube which comprises applying a layer of an enameling mixture to the inner surface of said tube, placing said tube around and spaced from an elongated electrical heating element, rotating said tube about its longitudinal axis while passing a controlled electric current through said heating element to bake said enameling mixture at a relatively low temperature, gradually increasing the current through said heating element until the softening temperature of the vitreous tube is approached and then maintaining the tube at this high temperature until the coating matures.

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