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COATING PERFORATE ARTICLES

Richard F. Farkas, Corning, N.Y., assignor to Corning Glass Works, Corning, N.Y., a corporation of New York

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This invention relates to a method of selectively coating perforate articles. More particularly the invention relates to a method of preparing a perforated article prior to the application of a coating thereto and, following the application of such coating, removing those portions thereof applied relative to the perforations in said article.

It is oftentimes desired to supply a coating to the surface of a perforate article such as a substrate, while leaving the perforations in such article free from the coating material. While such selective coating of an article having only a few and relatively large perforations presents little difficulty, the coating of the surface of an article having a large quantity of relatively minute cavities or perforations per unit of surface area, while leaving the cavities or perforations free of the coating, is considerably more difficult.

There is shown in Letters Patent of the United States 2,777,040, issued January 8, 1957, to Benjamin Kazan for Large Area Photocell, a light-sensitive device comprising a sheet of dielectric material which may have a thickness on the order of .010 inch and which is provided with a plurality of perforations having an average diameter of approximately .040 inch. A thin electrically conductive coating is provided over one or both sides of the dielectric material, leaving the perforations in the material uncovered, and the perforations are thereafter filled with a photoconductive material to complete the light-sensitive device. The difficulty in applying such an electrically conductive coating without also inadvertently filling the perforations in the dielectric material will be readily recognized.

It is accordingly an object of the present invention to provide a method of applying a coating to the surfaces of perforate articles, such as plastic or glass plates, or substrates, while leaving the perforations in the articles free of such coating. The inventive method disclosed herein can be employed in the application of coatings to articles or substrates having perforations of the diameter mentioned in the above Kazan patent, or to substrates having perforations of a substantially smaller diameter and manufactured according to a method hereinafter discussed.

In accomplishing the above object of the invention, the cavities or perforations in the article to be coated are first substantially filled with a pulverized abrasive material, the desired coating is then applied to the perforate surface of the article including the exposed surface of the filling material deposited in the perforations, and the coated article is then subjected to ultrasonic or supersonic vibrations to cause said abrasive material to disrupt and erode away those portions of the coating covering the filled perforations.

Other objects and characteristic features of the invention will become apparent as the description proceeds.

For the purposes of example only, the invention will be described in conjunction with the coating of a perforate glass article or substrate such as manufactured by the following described method.

Tungsten wire having a diameter of 1 mil is coated with glass having a composition approximately 76.9% SiO₂, 3.8% NaO, 2.0% K₂O, 13.9% B₂O₃, 1.7% Al₂O₃ and 1.7% U₃O₈, to a total thickness for the coated wire of 4.3 mils. Methods for coating wire with glass are well known, and one satisfactory method comprises heating a length of glass tubing to a temperature slightly above its softening temperature and drawing wire through the tubing.

After the wire is coated, it is cut into a plurality of lengths or segments which are arranged in parallel relationship with one another in a bundle and are pressed together in a container while they are heated to a temperature about 50° C. above the softening temperature of the glass, and maintained at that temperature for approximately 5-15 minutes to effect fusion of the glass into a single mass. The container is provided with a refractory lining to prevent the glass from adhering to its inner surface, and a cover is preferably provided with a weight to aid in pressing the coated wires together during fusion.

After the coated wires have been fused into a single mass, they are removed from the container, and the mass of wires is sliced along planes perpendicular to the wires to produce plates of the desired thickness. The plates so produced are then immersed in a fused mixture of equal parts by weight of NaNO₂ and NaNO₃ at a temperature of 340° C. For a plate having a thickness of 10 mils, the time required to completely remove the tungsten wires is approximately 8 hours. The resultant glass screen will have approximately 250 holes per linear inch, or approximately 62,500 holes per square inch, each hole having a diameter of about 1 mil. By utilizing finer wires with thinner coatings, it is possible to produce, by this method, screens having 250,000 holes per square inch.

If it is desired to form a glass plate having depressions therein rather than perforations, the above process may be modified by limiting the time during which the etchant remains in contact with the fused mass.

According to the present invention, the surface of an article or plate, having perforations made partially there-through in accordance with the method described above is first cleaned of contaminants by washing such surface in suitable mineral acids. A slurry of a suitable abrasive material such as powdered or pulverized glass is then prepared, the size of the particles of such material being substantially smaller than the size of the perforations in the perforate article, as for example, 1/10 or less than the size of such perforations.

The slurry is applied to the perforated surface of the article and the article is then placed in a vacuum chamber which is evacuated to cause the slurry to be drawn into the perforations. Alternatively, a dry pulverized or powdered abrasive may be employed for the filling material and such material caused to be deposited downwardly into the perforations by applying high frequency vibrations to the perforated article.

Following the filling of the cavities or perforations as discussed above, the perforated surface of the perforate article is cleaned with absolute alcohol or other suitable vehicle, and the article is then thoroughly dried.

In the fabrication of a photocell, such as disclosed in the above-mentioned Kazan patent, the coating to be applied to the perforate dielectric article or glass plate may be electrically conductive and it may also be desired that it be opaque. It has been found that an alloy comprising 80% nickel and 20% chromium provides these qualities even when deposited in a coating having a thickness of only 1000 Angstroms, and at the same time has other desirable characteristics such as durability. However, it is to be understood that coatings of other materials such as other alloys or metals, or glass or plastic compositions etc. may be chosen for specific applications and selectively applied by the method disclosed herein.

In employing a nickel-chromium alloy such as that mentioned above, the coating is preferably applied by the well known high vacuum deposition process, the alloy being evaporated in such a vacuum as from a suitable hot filament, for example. However, other suitable and well known methods of deposition of the coating material on the surface of the perforate substrate may be employed, the specific method employed being somewhat a matter

of choice and also dependent on the type of coating material to be deposited. It is pointed out, however, that the dimension of the thickness of the coating applied should be small relative to the size of the particles of the powdered filling material, the maximum size of such particles, as hereinbefore mentioned, being dependent on the size of the perforations in the surface to be coated.

By the above discussed coating deposition step the perforate surface of the article is provided with a thin film or coating which is continuous over such surface including the filled perforations. However, because of the comparative roughness of those portions of the coated surface comprising the filled perforations, such roughness being due to the relatively large size of the particles of the filling material as compared to the thickness of the applied coating, the coating covering the filled perforations is somewhat thinner than that over the remainder of the perforate surface. That is, the powdered or pulverized filling material in each perforation presents a somewhat larger area per square unit of area of the surface of the perforated article, as compared to the relatively smooth imperforate portions of the surface of said article, and, therefore, the coating over the filling material is thinner than that over the remainder of the perforate surface. In addition, the coating over the filled perforations is readily subject to fracture or may already be fractured to some extent due to the size of the particles of filling material as compared with the thickness of the applied coating.

Following the application of the thin film or coating as discussed above, the coated article or substrate is subjected to supersonic or ultrasonic vibrations, preferably by immersing the article in a bath comprising a vehicle such as alcohol and applying ultrasonic vibrations to the receptacle containing the vehicle. Such vibrations are imparted to the abrasive filling material in the perforations, and such material disrupts or completes the fracture of the relatively thin coating previously deposited over the surface of the filled perforations, the abrasive material then being vibrated out of the perforations while at the same time abrading away any of the coating material which may have become deposited on the interior sidewalls of the perforations, especially in the vicinity of the outer margin or edge of each perforation. It has been found that such treatment leaves the coating intact up to the edge or margin of each perforation and at the same time leaves the interior of each perforation free and clear of any coating material.

If a perforate article made in the manner hereinbefore described is to be employed in the manufacture of a light-sensitive device similar to that disclosed in the cited Kazan patent, it has been found desirable to coat or mask the perforate surface of said article with an opaque material in order to optically isolate each cell of the array of photoconductive cells formed by the subsequent deposit of a photoconductive material in the perforations in the perforate surface of said article. The method disclosed herein is ideally suited for masking or coating of a perforate substrate for such a purpose.

Although there is herein described only a single specific example of the utility of the inventive method disclosed, it will be readily apparent to those skilled in the art that such method can be employed for the coating of the perforate surfaces of numerous perforated articles while leaving the perforations themselves free and clear of the coating material. Accordingly, various changes and modifications in the materials and dimensions herein discussed

may be made without departing from the spirit and scope of the invention.

I claim:

1. The method of selectively disrupting and eroding a coating applied to a perforate article which comprises, filling the perforations in said article with a pulverized abrasive prior to the application of said coating, and subjecting said article to ultrasonic vibrations, following the application of said coating, to fracture and erode away those portions of the coating applied over the filled perforations.

2. The method according to claim 1 wherein said coating comprises a metallic material.

3. The method according to claim 1 wherein said abrasive comprises a pulverized glass.

4. The method according to claim 1 wherein said coating comprises a metallic material and said abrasive comprises a pulverized glass.

5. The method according to claim 1 wherein said article comprises a plastic material, said coating comprises a metallic material and said abrasive comprises a pulverized glass.

6. The method according to claim 1 wherein said article is a glass substrate, said coating comprises a nickel-chromium alloy coating and said abrasive comprises a pulverized glass.

7. The method of providing a mask on only the imperforate portion of a surface of a substrate provided with a multiplicity of perforations which comprises, filling said perforations with an abrasive, applying an adhesive mask to said surface, and supersonically vibrating said substrate whereby those portions of the mask covering the filled perforations become disrupted and are removed due to the wearing away of such mask portions by said abrasive.

8. The method of coating only the surface area surrounding a plurality of perforations provided in a surface of a substrate which comprises, at least partially filling said perforations with an abrasive material, applying a coating to said surface, and thereafter subjecting said substrate to a supersonically vibrated liquid bath whereby said material disrupts and abrades away that part of the coating applied to the filled perforations.

9. The method of selectively coating at least one surface of a perforate substrate which comprises, filling the perforations with a powdered abrasive material, applying a coating to the entire surface to be coated, and subjecting the substrate to an ultrasonically vibrated bath to cause said material to disrupt and abrade away that part of the coating applied over the filled perforations and be ejected therefrom.

10. The method of masking a selected area of a surface of a substrate having at least one cavity therein which comprises, filling said cavity with a pulverized abrasive material, applying a coating to said surface, and ultrasonically vibrating said substrate to cause said material to disrupt and abrade away that portion of the coating applied over the filled cavity thereby leaving only said selected area masked.

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