June 26, 1973 C. C. SIMMONS 3,741,793

METHOD OF ELECTROSTATICALLY COATING HOLLOW ARTICLES

Original Filed July 31, 1967 2 Sheets-Sheet 1

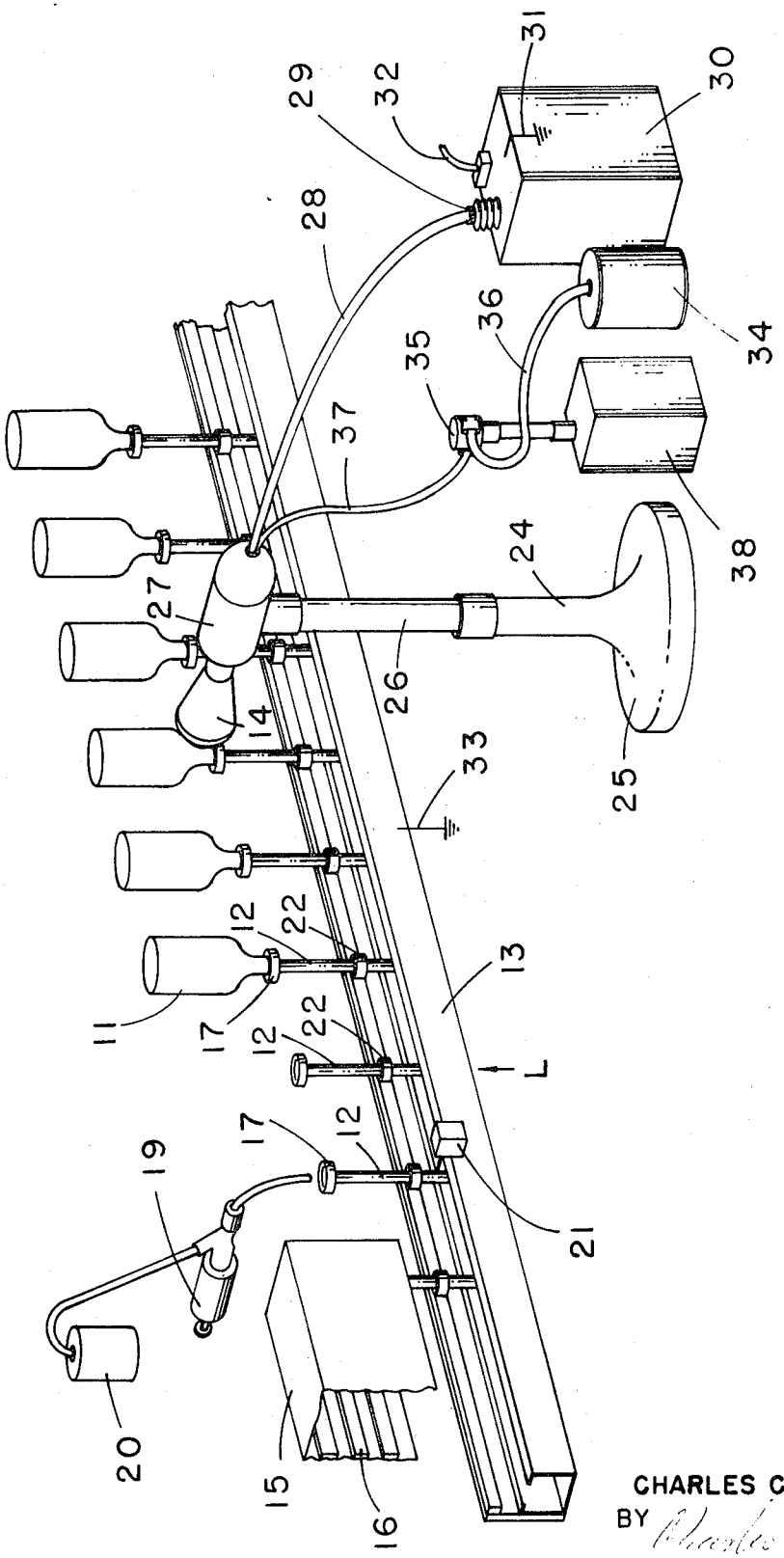

Fig. 1

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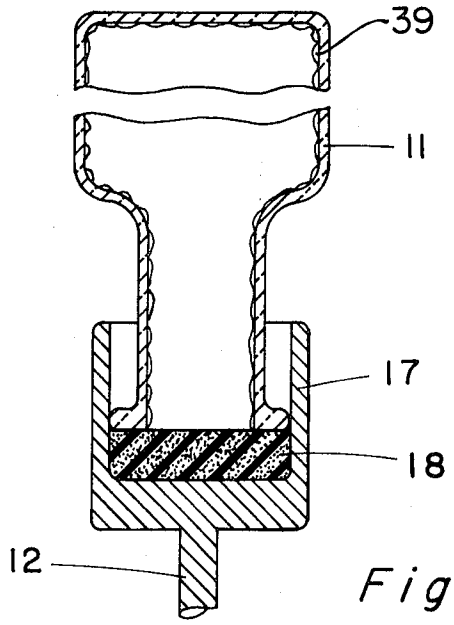

Fig. 2

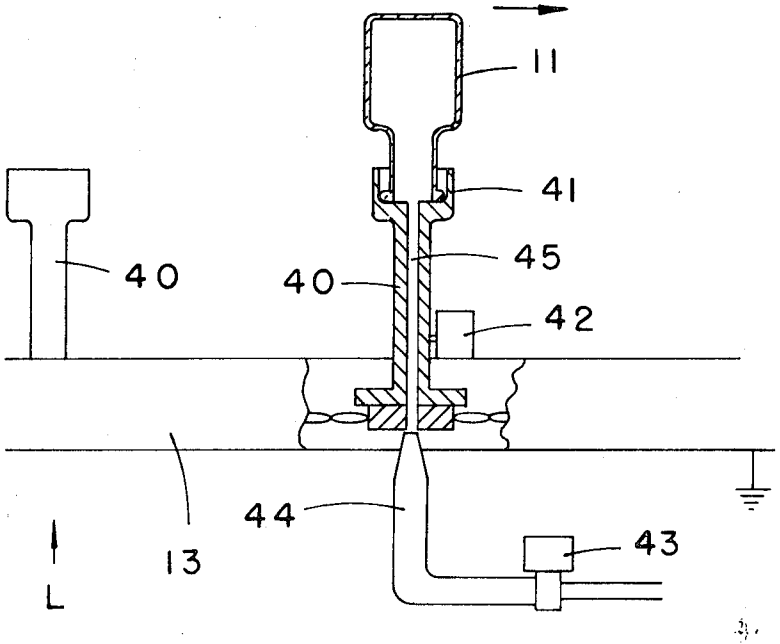

Fig. 3

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3,741,793

METHOD OF ELECTROSTATICALLY COATING HOLLOW ARTICLES

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Continuation of abandoned application Ser. No. 657,199, July 31, 1967. This application Aug. 12, 1971, Ser. No. 171,396

Int. Cl. B05b 5/02

U.S. Cl. 117—93.4 NC 7 Claims

ABSTRACT OF THE DISCLOSURE

Hollow articles of insulating materials such as glass bottles are electrostatically coated by introducing a vapor into their interior to be condensed into a conductive coating on their inside surface. The coating of condensate is maintained at a potential that attracts a spray of charged coating material particles to the outside surface of he aricle.

This is a continuation of Ser. No. 657,199 filed July 31, 1967, now abandoned.

This invention relates generally to an improved method of applying coatings to the exterior surface of hollow objects such as bottles, jars, glasses, or similar containers which are made of non-conducting materials such as glass or plastics. In particular, this invention relates to a method whereby such objects can have their surfaces coated using the well-known electrostatic deposition methods.

As has been known for a considerable period of time an object's surface can be coated with liquid or solid particulate material by electrostatically charging the coating material particles and introducing them adjacent the surface to be coated while the surface is maintained at particle attracting potenial with respect to the particles. Such coating can be done by several methods. For example in the method disclosed in U.S. Pat. Nos. 2,247,963 and 2,334,648 the article is positioned adjacent an electrode and the electrode is raised to a high electrical voltage with respect to the article. The material to be applied is then distributed as a spray of discrete small particles into the space between the electrode and the article. Under the action of the field between the electrode and the articles, the particles become charged to the same sign as the electrode and are, therefore, repelled by it and attracted to the articles. In another method applicable to the coating with liquid materials, the coating material is positioned as a thin extended film supported on a surface which is placed opposite to the article surface to be coated. The film is charged to a high potential with the respect to the article surface and under the action of this high potential the film is formed into a series of cusps. From the end of each of these cusps a succession of small highly charged liquid particles are formed. These particles because of their charge move toward and are deposited on the article surface. This process has the marked advantage of a very high utilization efficiency of the coating material. Other techniques of electrostatic deposition are in existence and can be utilized with the proposed invention.

In each of the above described methods the surface being coated must be brought into particle collecting relationship to the charged material. So long as the surface has some electrical conductivity this condition can be satisfied by placing the surface at a spray attracting potential. Metallic surfaces naturally have this property. If, however, the surface is made of an insulating material such as glass or plastic, the necessary conductivity is not present, and if the process is to operate satisfactorily, it becomes a requirement of the application of the process that the conductivity of the surface must be created or that an electrode at a spray-attracting potential be

placed behind the surface to be coated. U.S. Patent 2,723,921 discloses a method of electrostatic coating in which the necessary conductivity is imparted to a porous insulating surface by spraying it with or dipping it in a conducting liquid such as water. This method, however, could not be used with insulating surfaces such as glass or glazed ceramics because the water would not form a film on the surface and impart the necessary uniform conductivity to the surface to be coated. U.S. Patent 3,236,679 discloses a method of electrostatically coating an insulating surface by pretreating the surface to form an electrically conductive gel layer which is chemisorbed on the surface. Although this method can be used with insulating surfaces such as nonporous glass and glazed ceramic, its use is frequently undesirable because unless the gel layer is so formulated as to be assimilated into the applied coating it oft times will interfere with the adhesion of the coating to the surface. This method is particularly undesirable if the gel layer must be formed upon the inside surface of a hollow article such as a bottle because its residue may prove contaminating to the product eventually placed in the container. British patent specification 1,035,678 discloses the electrostatic application of coating material particles which are maintained in a vaporous atmosphere during coating to prevent a deposition inhibiting accumulation of electric charge on the article being coated and to facilitate the aggregation of the particles over the surface of the article. U.S. Patent 2,662,833 discloses a method of electrostatically coating hollow dielectric articles such as bottles by positioning within the bottle an ionizing discharge electrode to provide within the bottle an ionized cloud at spray attracting potential.

It is the object of this invention to provide a method of giving hollow articles, such as bottles, having non-conducting surfaces the necessary conductivity to allow them to be coated electrostatically. It is a further object of this invention to coat such articles without requiring a subsequent cleansing of their interiors. Another object of this invention is to establish the necessary conditions for electrostatic coating without contaminating the surface to be coated. Reference will be made to the following figures for further understanding of the invention.

FIG. 1 is an overall view of one form of the apparatus used in practicing the method.

FIG. 2 is a close-up view of the article and its support.

FIG. 3 is a portion of the apparatus of FIG. 1 modified to provide a conductive coating on the inside of the article by different means.

Referring to FIG. 1, the hollow articles to be coated are shown as glass bottles of a normal type. They are made of any of the standard bottle glasses which are electrically non-conductors at room temperature. Each bottle is positioned in a special workholder **12** which is made of metal and attached to a chain type conveyor **13**. The conveyor is arranged to transport the articles in succession past and in spaced relationship to an electrostatic atomizing bell **14** of the type described in more detail in U.S. Pat. No. 2,764,012.

In advance of the position at which the articles are loaded into the workholder, a box-type oven **15** may be located through which the top portion of the workholders **12** pass. Electrical element **16** within the oven when energized maintains the temperature within the oven well-above room temperature. The workholders passing through the oven as they travel along on the conveyor may be heated by this oven to a temperature sufficient to vaporize a liquid such as water.

Each workholder as shown in FIG. 2, has a cup-shaped receptacle **17** into which the neck of the article is inserted during the loading operation. Positioned along the conveyor intermediate between the oven **15** and a

loading station such as L there is located a liquid injection device **19**. This injection device is so positioned with respect to the workholders that when activated it will inject into the receptacle **17** of the workholder a small quantity of liquid. The liquid supply for this device is indicated as **20**. A microswitch activating means **21** is located adjacent the conveyor in such a position that it will be tripped by the passage of each workholder in turn. When the workholder is in position to trip the switch **21**, the switch will activate injector **19** and cause a small quantity of liquid material to be injected into the receptacle of the workholder. Loading of the article in the workholder will take place at a position along the conveyor that is sufficiently forward of the spray head **14** to permit the liquid to vaporize and condense on the interior surface of the bottle, for example, a distance sufficient to permit 14 to 20 seconds time between the loading at L and the passage past head **14**. A disk shaped porous member **18** capable of receiving and absorbing a liquid material such as water may be positioned at the bottom of the receptacle of each workholder. Such porous members are, however, unnecessary. The cup-shaped receptacle is desirably made of steel or other such material having a high specific heat. When the bottle **11** is placed on the workholder **12**, the opening of the bottle is positioned in receptacle **17** of the workholder in such a manner that the internal portion of the bottle is exposed to vapors given off from the liquid which has been injected into the receptacle.

Each of the workholders are so attached to the conveyor **13** as to be free to rotate about their axis. Each is likewise equipped with a gear or pulley **22** which contacts a stationary bar **23** positioned alongside the conveyor in such a way as to cause the supports to rotate as they are carried along on the conveyor. Electrostatic atomizing bell **14** to produce a spray of charged coating material particles is positioned downstream from the loading position L. The atomizing bell is mounted on a support stand **24** which consists of a base **25** and an insulating column **26**. The bell **14** of the atomizer is mounted on its rotating motor **27**. The rotating motor and bell of the atomizer are connected by means of an insulation-covered conducting cable **28** to the outlet **29** of a DC high voltage supply **30**. The other end of the high voltage supply is grounded as at **31**. The high voltage supply **30** is connected to a voltage source of relatively low voltage by connections **32**. In this manner the input voltage supplied at **32** is amplified and rectified by suitable electrical components within the supply **30** so that the output at terminal **29** is a high voltage of approximately 100 kilovolts DC. This voltage by way of conductor **28** is applied to the atomizing head **14** which is thus maintained at high voltage with respect to the objects on the conveyor. The conveyor itself is maintained at ground potential by connection as at **33**.

The coating material to be applied to the surface of the bottles is contained in container **34** and is pumped by way of pump **35** through hose **36** and **37** from the container to the back end of the drive motor **27** of the atomizing bell **14**. This material is supplied at a controlled rate by means of varying the speed of the pump **35** through its regulatable drive arrangement **38**. The coating material is supplied to the rear end of the hollow shaft of the atomizer and eventually appears as an extended thin film at the forwardly disposed edge of the cone shaped atomizer.

In operation of the invention the conveyor is set into motion. The movement of the conveyor carries the spindle and its upper support receptacle **17** into oven **15** which raises the temperature of the receptacle to a temperature sufficient to vaporize quickly the liquid injected into it by liquid injection device **19**. As the spindle exits from the oven it contacts switch **21** which energizes the injector **19** which in turn injects a small amount of water, or similar liquid, into the receptacle **17** of the holder. If the oven **15** is not available for use, the liquid may be heated prior to its injection into the receptacle. For example, good results have been obtained when water at a temperature of 170° F. has been injected into a receptacle that is at a temperature of 100° F. The spindle advances to loading station L where the bottle **11** is placed in the receptacle **17**. Because the liquid is at a temperature sufficient to vaporize, the liquid vapors from the liquid will accumulate onto the inside surface of the bottle **11** which is maintained at a vapor condensing temperature such as room temperature. This condensation will be relatively uniform over the entire internal surface and will have served to establish on the inside surface of the container a coating **39** (FIG. 2) which will be electrically conducting and electrically connected to receptacle **17** at the workholder **12**. As the object is transported along the conveyor it comes into spraying relation with the atomizing head **14**. The conducting coating **39** on the inside of the container will be maintained at ground potential by virtue of being connected to the conveyor by way of the workholder **12**. The electrostatic atomizer **14** will be maintained at high potential by virtue of being connected to the voltage supply **30**. An electrostatic field is therefore established between the internal conducting layer **39** of bottles **11** and the atomizing head **14**. Under the action of this field the coating material which appears at the forward edge of the atomizing bell as a thin extended film will be broken up into a number of small charged particles which will be attracted toward the conducting layers **39** on the inside surfaces of the bottles **12**. These particles will be intercepted by and deposited on the outer surface of the bottles **12** which, therefore, will be coated in the desired fashion.

This invention allows the high efficiency of electrostatic deposition methods to be applied to the coating of objects which are normally made of non-conducting materials. As the object after being coated passes into an oven which is responsible for the curing of the coating material, the conductive layer **39** will be further vaporized and will leave the internal surface of bottle **12** in exactly the same condition it was prior to the accumulation of the condensed liquid vapor.

It will be evident that if the interval between the coating material curing station and the coating station is short the oven **15** is not necessary to heat the receptacles because the receptacles of the workholder will return to the coating station sufficiently hot to vaporize the liquid, having been heated during their passage through the coating material curing oven. Under these circumstances it will only be necessary to remove the bottle with its cured coating from the spindle, inject a new quantity of liquid into the receptacle in the workholder and load a new bottle onto the workholder before it passes into the coating station.

In practicing the method of this invention, the liquid injection apparatus can be eliminated by immersing the neck of the bottle (that portion of the hollow article adjacent the opening) prior to placing it on a heated support.

Many liquids may be used to form a conductive coating inside the bottles. It is only necessary that the liquids chosen be conductive enough in its liquid state to form a conductive layer, such as tap water or most polar organic solvents. Tap water is a preferred liquid since it is inexpensive, readily available, can be vaporized during the curing of most coating materials, and will not leave any harmful residue.

FIG. 3 shows another embodiment of the invention. In this embodiment the workholder **40** advances to the loading station L where a bottle **11** is placed into the receptacle **41** of the workholder. As the conveyor advances the workholder and article toward the coating station, workholder **40** trips a switch **42** supported by conveyor **13**. Switch **42** opens a valve **43** which permits the flow of a

vapor, such as steam, through nozzle **44**. Nozzle **44** directs the vapor through a passageway **45** in the workholder and into the interior of the bottle where it condenses to form the conductive film.

Whenever I use the term bottle in this application, it is understood that I mean any hollow article such as bottles, glasses, jars, bowls, cups, angle irons, concave articles and other such containers. The methods of this invention may be used with other types of material applicators. Electrostatic compressed air or hydraulic atomizers may be used instead of the bell illustrated to produce a spray of charge coating material particles. Likewise coating materials in forms other than liquids can also be used. Powders can likewise be applied electrostatically using these techniques. The described details of the operation are intended to be illustrative only and are in no sense to be considered as limiting on the disclosed invention.

I claim:

1. A method of forming a coating on the exterior surface of a bottle, comprising the steps of injecting water into a receptacle portion of a moving support of a conveyor, the receptacle portion being hot enough to vaporize the water, placing the bottle upside down in the receptacle portion of the support, maintaining the bottle at substantially room temperature to condense evaporated water on the inside surface of the bottle in the form of a coating while moving it to a spray coating zone, producing a spray of charged coating material particles adjacent the bottle while connecting the condensed water coating inside the bottle to ground potential to deposit the coating material on the exterior of the bottle, and heating the coated bottles to cure the coating on the exterior of the bottle and evaporate the water inside the bottle.

2. The method of claim **1** including the step of transporting the support of the conveyor between the point at which the exterior coating of the bottle is cured and the water inside the bottle is evaporated and the point at which the water is injected quickly enough so that the heat absorbed by the receptacle during curing of the coating material may be used to vaporize the water.

3. The method as set forth in claim **1** wherein the projection of a spray of charged coating material at the bottle comprises the steps of supplying a liquid coating material to a surface of an atomizer, forming the coating material into a thin extended film supported on the surface, and establishing an electrostatic field between the thin extended film of coating material and the condensed water coating on the inside of the bottle to atomize the coating material for deposition on the outside surface of the bottle.

4. A method of forming a coating on the exterior surface of a bottle, comprising dipping the neck of the bottle into a conductive liquid to be vaporized, placing the bottle upside down on a heated support, connecting the support to ground potential, condensing vaporized liquid to form a substantially uniform conductive film on the interior surface of the bottle, transporting the bottle past a source of electrically charged coating material particles while maintaining the film at a spray attracting potential to deposit charged coating material particles on the exterior surface of the bottle, and heating the coated bottle to cure the coating material on the exterior of the bottle and to evaporate the film formed on the interior surface of the bottle.

5. A method of forming a coating on the exterior surface of a bottle, comprising injecting an electrically conductive liquid to be vaporized into a heated receptacle, placing the neck of the bottle in the receptacle so that its interior is exposed to the surface of the liquid, connecting the receptacle to ground potential, condensing the vaporized liquid to form a substantially uniform conductive film on the interior surface of the bottle, transporting the bottle past a source of electrically charged coating material particles while maintaining the film at a spray attracting potential to deposit charged coating material particles on the exterior surface of the bottle, and heating the coated bottle to cure the coating material on the exterior of the bottle and to evaporate the film formed on the interior surface of the bottle.

6. An apparatus for electrostatically applying coating material particles to a first insulative surface of a hollow article, comprising

means to introduce a vapor adjacent a second inside surface of the article, including a liquid injection device, a source of hot liquid to be vaporized, a support including a receptacle to hold the liquid and the article, means to operate the liquid injection device to inject a small amount of liquid into the receptacle, the vapor of said liquid condensing upon the second inside surface of the article to form a substantially uniform conductive film thereon,

means connected to the conductive film for maintaining the conductive film at a coating material particle attracting potential, and

means to provide a spray of charged coating material particles adjacent the first insulative surface of the article, the charged particles of coating material being drawn toward and deposited upon the first insulative surface of the article.

7. The apparatus of claim **6**, including means to move the support, means to operate the liquid injection device as the receptacle of the support passes the liquid injection device and to inject a small amount of liquid into the receptacle, and heating means for the receptacle located to heat the receptacle prior to its passage past the liquid injection device.

References Cited

UNITED STATES PATENTS

2,723,921	11/1955	Starkey	117—93.4 NC
3,342,621	9/1967	Point et al.	117—93.4 NC

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