April 25, 1939. H. C. DAVIS 2,155,932

PROCESS OF DEPOSITION

Filed April 26, 1938 2 Sheets-Sheet 1

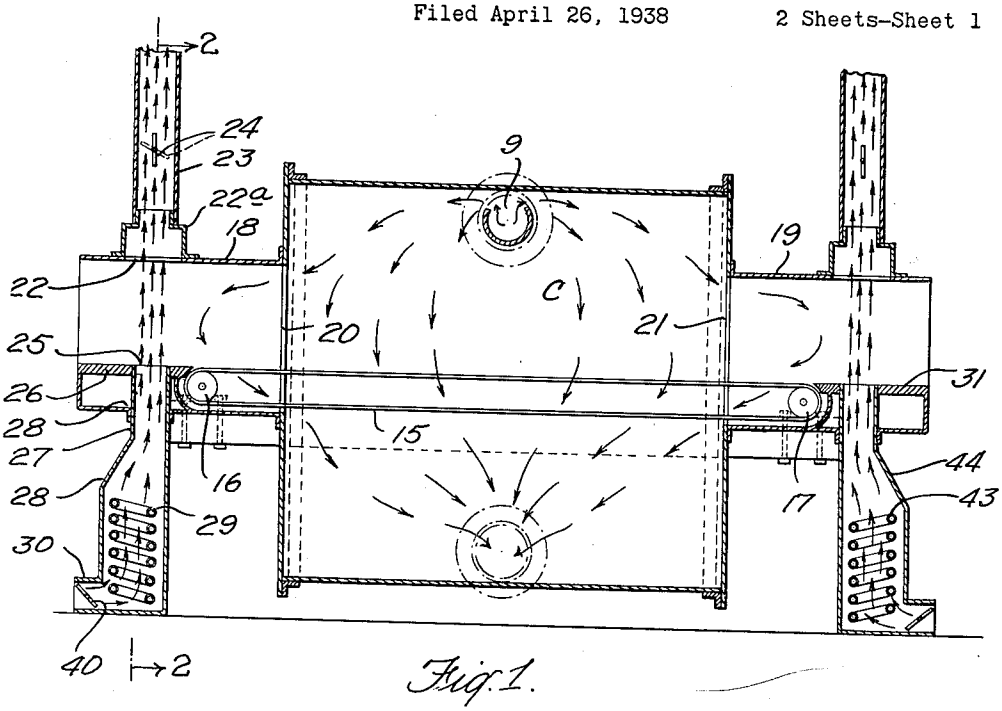


Fig. 1.

Fig. 3.

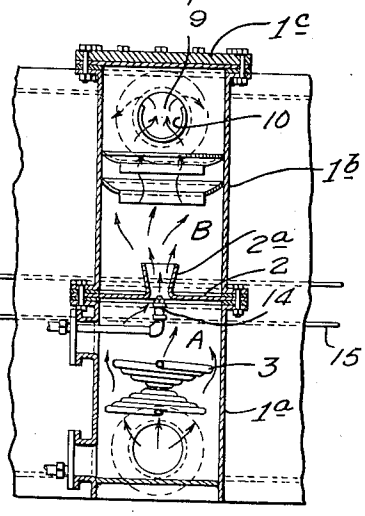
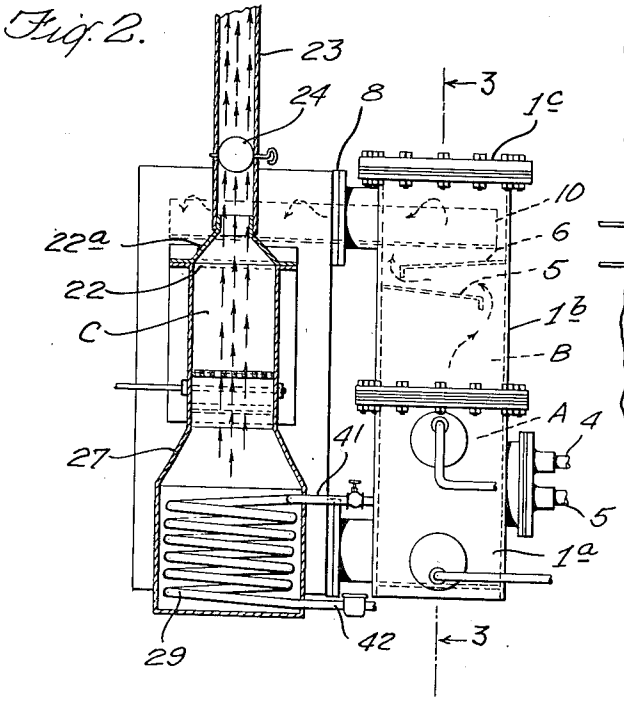


Fig. 2.



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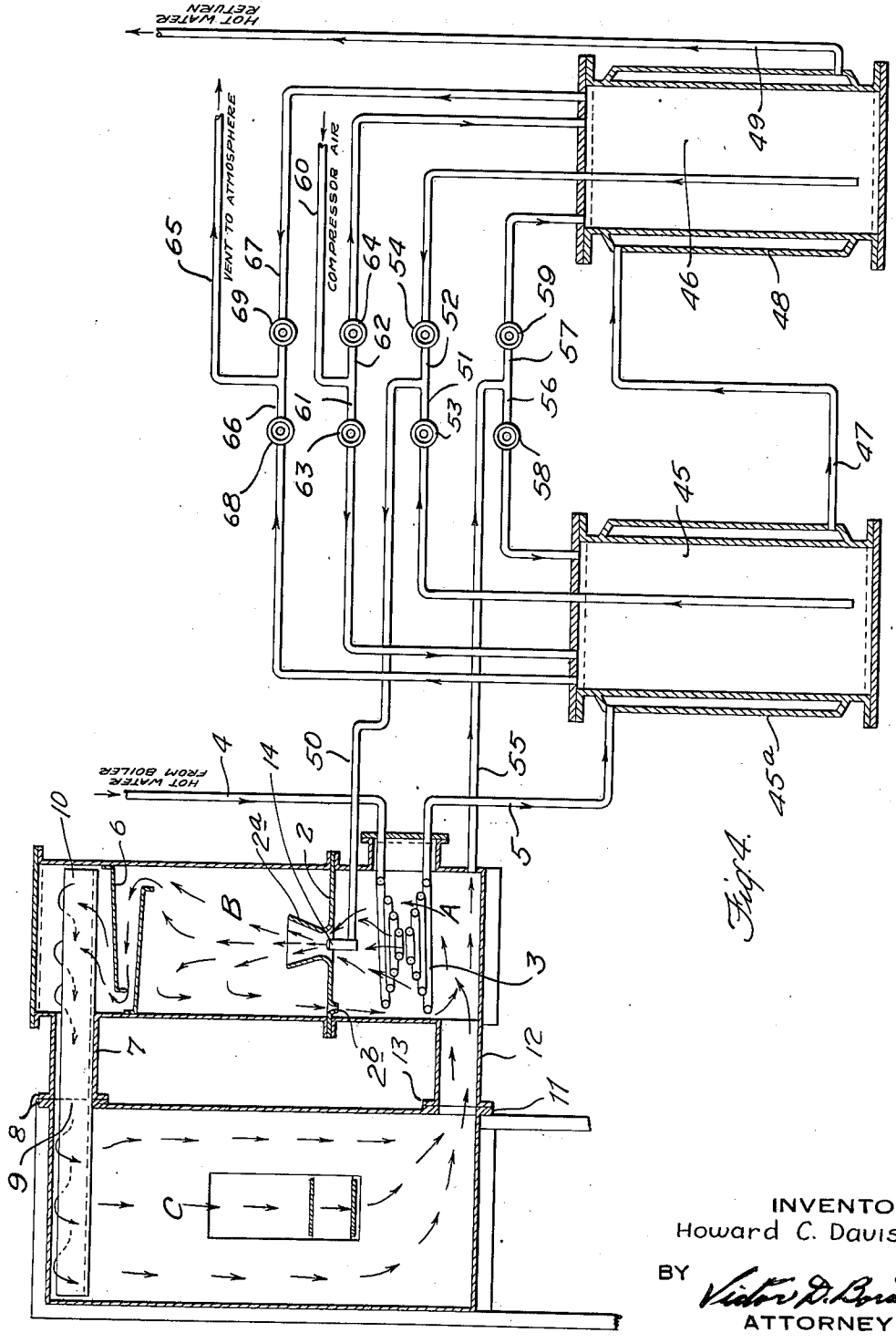


Fig. 4.

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Patented Apr. 25, 1939 2,155,932

UNITED STATES PATENT OFFICE

2,155,932

PROCESS OF DEPOSITION

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Application April 26, 1938, Serial No. 204,481

7 Claims. (Cl. 41—42)

The invention herein disclosed relates to a process for treating articles by depositing a substance upon the surfaces of articles to be treated. More particularly, the invention relates to a process for effecting the deposition of substances in finely divided or atomized form to secure a homogeneous and uniform deposit on the surfaces of articles.

The process essentially comprises utilizing a carrier substance for conveying the substance to be deposited in finely divided form to the article. This carrier substance is one that is in a gaseous state under normal atmospheric conditions of temperature and pressure and the carrier utilized is one that is substantially chemically inert with respect to the substance to be deposited and the article to be treated. The substance to be deposited is either normally in a liquid state or if normally in a solid state, it is dissolved in a liquid. In carrying out the process, the temperature and relative humidity of the gaseous carrier is fixed at a predetermined value. The liquid substance is maintained at a temperature below the boiling point thereof and it is divided into a finely divided form. The temperature of the gaseous carrier is maintained substantially above the temperature of the article upon which the liquid substance is to be deposited and the gaseous carrier is circulated to successively bring it into contact with the liquid in finely divided form and then into contact with the article. In this way the liquid is converted into a state in which it obeys the laws pertaining to gases and carried to the article by the gaseous carrier. The liquid is reconverted into the liquid state and deposited upon the article when brought into contact with the article. A uniform, homogeneous coating is thus obtained over the surface of the article and where the liquid is a solution and the liquid is evaporated from the surface of the article, a homogeneous, uniform coating of the dissolved matter remains on the surface of the article.

In most uses to which the process is applicable, air may be used as the gaseous carrier. When used as the gaseous carrier, the air is first dehumidified by any of the methods now employed for reducing the moisture content of air. For example, the air may be circulated over or through beds charged with an absorbent having an affinity for moisture such as calcium chloride, silica gel or aluminum salts. Or the moisture content of the air may be materially reduced by lowering the temperature of the air as by circulating the air over or through a series of coils through which a refrigerant is circulated. When so cooled, all moisture above the saturation point of the air at the lower temperature is removed.

The air, after the removal of the mositure, is passed through a heating chamber wherein the temperature of the air is raised substantially. This may be accomplished by employing in the heating chamber ordinary heating coils through which either steam or hot water passes, the latter being preferable as it is more readily controlled. The elevation of the temperature of the air raises the saturation point of the air and correspondingly reduces the relative humidity.

The heated air is circulated into contact with the liquid substance in finely divided form. In some instances the circulation of air may be effected by a fan or blower, in others it may be effected by a Venturi tube arrangement in which the liquid substance is forced through a fine atomizing jet so that an injector effect is obtained. In both instances the liquid substance is divided into a finely divided or atomized form and thus presented to the moving heated air. The atomized liquid is taken up by the heated air until the liquid content of the air corresponds to its saturation point at the temperature of the air.

The air is then circulated at a very low velocity through a treating chamber that contains the articles upon which the liquid is to be deposited. The relative temperature conditions of the carrier air and the articles is such that upon coming into contact with the articles the liquid carried by the air is reconverted into the liquid state and deposited uniformly over the surface of the articles. In most instances the articles to be coated will be moved in continuous succession through a treating chamber and the time of passage through the treating chamber may be regulated. The carrier air will be circulated and recirculated in the cycle described which includes the treating chamber. The amount of the deposit on an article will, of course, depend upon the moisture content of the carrier air, the relative temperatures of the air and the articles and the time the article remains in the treating chamber.

This process has many different applications. It is suitable for impregnating materials, for film coating exposed surfaces of materials, dyeing fabrics, etc. Examples of some of the uses to which the process is applicable are given below. Others will be suggested by the examples.

One purpose for which the process is especially suitable is etching glass. In this process the carrier gas used is air and the substance used for etching the glass is hydrofluoric acid. Throughout the process there is no chemical change effected in the hydrofluoric acid, except as is effected in its action upon the glass, but its physical characters are changed in that it is converted from the liquid state into a state in which it follows the laws pertaining to gases and it is reconverted and deposited on the glass as a liquid. The entire process is carried out in apparatus provided for the purpose and in the manner heretofore described air is dehumidified and then heated. It is caused to flow in a cycle including the heating chamber wherein the heating of the air is effected, a chamber in which the hydrofluoric acid is vaporized and the treating chamber. The carrier gas is continuously circulated and recirculated in this cycle and the glass articles to be etched pass through the treating chamber in continuous succession. The hydrofluoric acid is thus uniformly deposited over the surfaces of the articles and the glass is etched by the action of the acid on the glass.

One form of apparatus that may be used in etching glass in this manner is illustrated in the accompanying drawings in which:

Fig. 1 is a longitudinal section through the treating chamber of the apparatus;

Fig. 2 is a transverse section of the same taken on the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary, sectional, side elevation taken on the line 3—3 of Fig. 2; and

Fig. 4 is a partially diagrammatic illustration of the connections of the apparatus.

The apparatus illustrated in the drawings includes a heating chamber A, an atomizing chamber B, and a treating chamber C, all of which are arranged to form a continuous circuit so that the carrier air may be circulated in a cycle through these chambers successively—in the direction indicated by the arrows. The heating chamber A and the atomizing chamber B are contained in a cylinder having two sections 1*a* and 1*b*. The lower end of the section 1*a* is closed and on the upper end there is a flange which is connected to a similar flange on the lower end of the section 1*b*. The upper end of the section 1*b* is also provided with a flange to which a cover 1*c* is secured.

The heating chamber is in the section 1*a* of the cylinder and it is separated from the atomizing chamber B by a diaphragm 2 having a Venturi tube 2*a* extending from the center thereof and forming the air passage between the heating and atomizing chambers. The diaphragm 2 is secured between the flanges of the upper and lower section of the cylinder. A drain 2*b* is provided in the diaphragm for draining acid from the chamber B into the chamber A which also forms a sump for the excess acid. Within the chamber A there is a heating coil 3 through which hot water obtained from a boiler (not shown) is continuously circulated, the supply being indicated by a pipe 4 and the outlet from the heating coil being indicated by pipe 5. This heating coil is provided for the purposes of heating the circulating carrier air.

Near the upper end of the section 1*b* of the cylinder, which forms the atomizing chamber, there are provided two baffles 5 and 6 which cause the circulating air to move transversely of the cylinder and which act to remove any entrained liquid from the air, that is, any of the liquid entrained in globular form. At the upper end of the cylinder 1, there is a lateral hollow boss 7 which is connected through flanges 8 to the upper end of the treating chamber C. Through the passage provided by the boss 7 and the opening 9 in the wall of the heating chamber with which it communicates, a circular trough-shaped element 10 extends. This trough-shaped element extends from the far wall of the atomizing chamber to the far wall of the heating chamber and is open along its upper edge. The carrier air on reaching the top of the atomizing chamber flows over the edge of the trough, into the trough, through the trough and again over the edge of the trough into the treating chamber.

The treating chamber is rectangular in section. It is connected at the lower end to the heating chamber through a flange connection 11 to a hollow boss 12 extending from the heating chamber and through which the treating chamber C communicates with the heating chamber A. Through these connections the air thus circulates from the treating chamber to the heating chamber, through the heating coil 3, through the Venturi tube 2*a* in the diaphragm 2 into the atomizing chamber and through the trough-shaped conduit 10 back to the treating chamber. It will be noted that the cross-sectional area transverse to the flow of air in the treating chamber is many times larger than the area of either the heating chamber or the atomizing chamber transverse to the direction of flow in these chambers. In view of this fact, while the air may have a substantial velocity in the heating and atomizing chambers, it will have a relatively low velocity in the treating chamber. The velocity of the air in the heating and atomizing chambers is so taken that the air moves through the treating chamber at a very low velocity.

The air is caused to flow in the cycle including the heating chamber A, the atomizing chamber B and the treating chamber C, by virtue of the force of the acid issuing from an atomizing jet 14, the opening from which extends into the lower end of the Venturi tube 2*a*. This atomizing jet may be any one of several known types and the atomization may be effected if desired by the employment of centrifugal forces. The acid utilized in etching the glass is forced through the jet 14. On being forced through this jet the acid is atomized, driven at high velocity through the Venturi tube 2*a* and causes the air to flow in the cycle just mentioned. The air may also be caused to flow in the cycle by employment of a fan or blower where desirable.

Extending through the treating chamber C, there is a continuous conveyor 15 that is stretched over pulleys 16 and 17 which are outside of the treating chamber per se but within extensions 18 and 19 respectively extending from the ends of the treating chamber. This conveyor belt is driven in the usual way by a motor (not shown) connected to one of the shafts on which a pulley is mounted. The conveyor belt, which is made up of a plurality of individual belts formed from wire wound in a helix, extends through openings 20 and 21 in each end wall of the treating chamber. The arrows adjacent the conveyor belt indicate the direction in which the conveyor is normally driven although it may be driven in either direction.

The extension 18 from the end wall of the treating chamber is likewise rectangular in cross-section. On the upper side of this extension and covering an opening 22 through the upper wall thereof and extending from side wall to side wall,

there is mounted a hood 22a on which there is a stack 23 having a damper 24 therein. Another rectangular opening 25 constituted by a series of slots is provided across a receiving table 26 mounted in the extension 18. A stack 27 communicates with this opening in the table, the stack passing through an opening 28 in the lower wall of the extension 18. The stack 27 is enlarged as at 28 and contains a heating coil 29 through which hot water or steam is circulated. Air enters the lower end of the stack 27 through an opening 30 in which there is a regulating damper 40.

By virtue of the transfer of heat from the coil 29 to the air, there is an upward flow of hot air through the stack 27, across the extension 18 and through the stack 23. The flow of hot air across the extension 18 forms a hot air curtain slightly higher in temperature than the gases in the treating chamber which prevents any of the air in the treating chamber from passing out to the atmosphere. At the same time, there is obtained an unobstructed opening through which the glass articles can be moved onto the table 26 and from there onto the conveyor belt 15 on which they are carried through the treating chamber C and delivered to a delivery table 31 in the extension 19. The extension 19 is identical in all respects with the extension 18 and a curtain of warm air is likewise formed across the extension 19 to prevent the flow of the acid-ladened air in the treating chamber out into the atmosphere. The coil 29 in the stack 27 is supplied wtih hot water or steam through a supply pipe 41 and the hot water or steam is returned through a return pipe 42. Similar connections are provided for a heating coil 43 in the stack 44 utilized in conjunction with the extension 19 and for forming the curtain of hot air adjacent the end of this extension.

Acid is supplied to the atomizing jet 14 from acid tanks 45 and 46. The acid tank 45 has a circumferential jacket 45a that is connected to the return pipe 5 from the hot water heating coil 3. The hot water from the coil 3 enters this jacket and maintains the acid therein warm. An outlet from the jacket 45a is connected by a pipe 47 to a similar jacket 48 on the tank 46. From the jacket 48 the hot water is returned to the boiler through a return pipe 49. These tanks supply acid to the acid atomizing jet 14 successively. While the acid from one tank is being forced through the jet 14, the other tank receives the acid that is not taken up and carried by the air and that drains into the heating chamber A. When one tank is emptied, acid is supplied from the other tank, and the first tank becomes the tank that receives the return acid. For this reason the two tanks are connected in common to the several pipes for delivering acid from the tanks and returning acid to the tanks. The atomizing jet 14 is thus connected to a supply pipe 50 which is connected in common to pipes 51 and 52 that lead to a point adjacent the bottom of the tanks 45 and 46 respectively. In the pipe 51, there is a valve 53 and in the pipe 52 there is a valve 54 so that either tank may be opened to the pipe 50 or shut off therefrom. The acid not taken up by the air is collected on the bottom of the heating chamber A and passes through a return pipe 55. This return pipe is connected in common to pipes 56 and 57 which are respectively connected to the tanks 45 and 46. In the pipe 56 there is a valve 58 and in the pipe 57 there is a valve 59. The acid is forced out of the tanks and through the jet 14 by compressed air that is delivered to the top of the tank thus pressing upon the acid and forcing it up either the pipe 51 or 52 depending upon which tank is connected to the acid atomizing jet 14. This compressed air is delivered from a source of compressed air through a pipe 60 that is connected in common to pipes 61 and 62 which in turn are respectively connected to the tanks 45 and 46. In the pipe 61 there is a valve 63 and in the pipe 62 there is a valve 64 so that either one or the other of the tanks can be connected to the supply of compressed air. When a tank is receiving the return of the acid, that tank is vented to the atmosphere and for this purpose there is provided a vent pipe 65 which is connected in common to a pipe 66 and a pipe 67. The pipe 66 is connected to the tank 45 and the pipe 67 is connected to the tank 46. In the pipe 66 there is a valve 68 and in the pipe 67 there is a valve 69.

In operation, air that has been fixed with reference to its temperature and relative humidity is introduced into the apparatus. A heating medium is supplied to the coils 29 and 43 to form curtains of hot air across the openings provided by the extensions 18 and 19 of the treating chamber. The conveyor belt 15 is caused to operate by rotation of the pulleys. Hot water is supplied through the pipe 4 to the heating coil 3 in the heating chamber A. From this coil the hot water flows to the jacket 45a surrounding the acid tank 45 and from the jacket 45a through the pipe 47 to the jacket 48, surrounding the tank 46, and from the jacket 48 back to the boiler by way of the return pipe 49. When the acid is warmed to the desired temperature, substantially below the boiling point, the apparatus is ready for operation. When this occurs, valves 59, 53, 63 and 69 are opened. Valves 68, 64 and 54 are closed. With this relation of the several valves, the top of the tank 45 is connected through the pipe 61 to the supply of compressed air represented by the pipe 60. The pipe 50 supplying the atomizing jet 14 is connected through the pipe 51 to the tank 45. Likewise, the tank 46 is connected to the vent pipe 65 through the pipe 67. It is closed off from the compressed air, and it is shut off from the supply pipe 50 by the valve 54. The tank 46 however is opened to the acid return pipe 55 through the pipe 57. The tank 45 is of course closed off from the vent to the atmosphere and from the acid return pipe 55. Under these conditions the compressed air acting upon the upper surface of the acid in the tank 45 forces the acid through the pipe 51, the acid supply pipe 50 and through the jet 14. As the acid issues from the atomizing jet 14 under pressure and into the Venturi tube 2a, the air in the apparatus is caused to circulate. On circulating, it mixes with the acid that is transformed into a condition in which it responds to the law of gases and with the air it is carried around the baffle 5 and around the baffle 6 and into the trough-shaped element 10. Any entrained acid will be removed by the baffles 5 and 6. It will be noted that these baffles are tilted with respect to the horizontal so that any of the entrained acid depositing thereon will drip back to the plate 2 and through the drain therein to the bottom of the heating chamber. This liquid acid will thus be returned through the pipe 55 to the tank 46. The mixed air and acid will flow through the trough-shaped element 10 and into the treating chamber C.

The glass articles to be etched are moved in continuous succession onto the table **26** and from there onto the conveyor **15** so they pass through the conveyor in a continuous series The relation of the circulation set up by the jet through the Venturi tube 2*a* is such that with respect to the cross-sectional area transverse to the direction of flow of the air in the treating chamber, the air moves through the treating chamber at a very slow rate, a rate such that the thermal difference between the air and the glass articles, which are introduced at normal room temperature, is sufficient to create eddy currents in the air so that the acid-ladened air contacts with all surfaces of the glass articles passing through on the conveyor. The conveyor itself is as stated formed of a series of belts, each of which is a convolute wire in the shape of a spring, thus providing space through which the acid-ladened air can contact with all surfaces of the glass. It will be understood of course that if the velocity of air in the treating chamber is sufficiently high to prevent the formation of the eddy currents that result by virtue of the thermal difference between the air and the glass articles, the acid-ladened air will no come in contact with all surfaces of the glass and it is for this reason that the velocity of the air in the treating chamber must be kept very low. Upon coming in contact with the glassware which is at room temperature and a temperature substantially lower than the temperature of the acid-ladened air, the acid in the air is reconverted into the liquid state and deposited upon the glassware, and forms a uniform liquid film over the entire surface of the glass. The air passes from the treating chamber into the bottom the heating chamber below the coil **3**. This constitutes a cycle of the circulation of the carrier air and the air is continuously recirculated in this cycle during the operation of the apparatus.

As the glass articles issue from the extension **19** of the treating chamber and pass through the curtain of hot air, they may be sprayed with water to remove the acid if the etching process be sufficiently complete or they may be carried on and further processed. Anything done after the glass articles leave the treating chamber will depend entirely upon the effect desired on the glass.

When all of the acid or nearly all of the acid is expelled from the tank **45**, the valves **63** and **53** are closed and the valves **66** and **58** are opened. At the same time, the valves **69** and **59** are closed and the valves **54** and **64** are opened. When this is done, the tank **45** is connected to the acid return line **55**; it is cut off from the acid supply line **50** and cut off from the compressed air line **60** and opened to the vent **65**. The tank **46** is cut off from the acid return line **55**, opened to the acid supply line **50**, opened to the air compressor line **60**, and cut off from the vent **65**. The acid is then delivered from the tank **46** and returned to the tank **45**. The two tanks are thus alternately utilized for supplying the acid until all of the acid of both tanks is utilized. All of the parts of the apparatus that carry the acid or with which the acid or acid-ladened air comes into contact, are of course properly lined with lead. It is to be noted that, with the exception of the conveyor belt, there are no moving parts that come into contact with the acid or acid-ladened air.

From the foregoing it will be seen that by the apparatus hereinabove described, which forms a part of this invention, the process of the invention may be continuously carried out and a uniform deposition of a liquid substance may be effected upon the surfaces of articles. The amount of liquid that is deposited on the articles will of course depend upon several factors including the temperature of the carrier air, the temperature of the articles, and the speed at which the articles move through the treating chamber. The heat supplied to the tanks **45** and **46** is insufficient to raise the temperature of the liquid content of these tanks to the boiling point thereof.

It is essential that the temperature be maintained below the boiling point. This is particularly true where the process is utilized for depositing a solid substance upon articles. In such instance, the solid substance is dissolved in the liquid and the process carried out as hereinbefore described, the solution being the liquid that is carried by the carrier gas. When the liquid is deposited upon the articles and evaporated, tne solid dissolved in the liquid remains as a homogeneous deposit upon the surface of the article.

In a similar manner, a homogeneous coating of wax may be obtained on the surfaces of articles such as paper, for example. For this purpose, a water soluble wax may be utilized. The wax is first dissolved in water to form a water solution of the wax. The solution of wax is atomized in the atomizing chamber and taken up by the air. In the treating chamber, the solvent carrying the wax is deposited upon the paper leaving a homogeneous deposit of wax on the article when the water is evaporated.

Another application of the process is lacquer coating of various articles. When lacquer is used as the vehicle for a pigment, the lacquer containing the pigment is atomized and the lacquer-laden air is delivered to the treating chamber where it is deposited upon the surface of the material to be treated. In this way, metal, wood, fiber, glass or other materials may be given a thin coating of lacquer to prevent tarnish or mold on material subject to such surface conditions.

It is obvious that various changes may be made by those skilled in the art in the steps of the process and the details of the apparatus described above within the principle and scope of the invention as expressed in the appended claims.

I claim:

1. The process for effecting a uniform deposition of a liquid substance over the surface of an article which process comprises utilizing a carrier substance that is in a gaseous state under normal atmospheric conditions for conveying the substance to be deposited on the article, the gaseous carrier being substantially chemically inert with respect to the liquid substance and the article and which process includes the steps of fixing the temperature and relative humidity of the gaseous carrier, dividing the liquid substance into a finely divided form, maintaining the temperature of the liquid substance below the boiling point thereof, maintaining the temperature of the carrier gas substantially above the temperature of the article, and circulating the gaseous carrier to successively bring it into contact with the liquid in finely divided form and then into contact with all surfaces of the article, whereby the liquid is converted into a gaseous state, mixed with and carried by the gaseous carrier to the article whereon it is reconverted to the liquid state and deposited on the surface of the article on coming in contact therewith.

2. The continuous process for effecting a uniform deposition of a liquid substance over the surface of a series of articles which process comprises utilizing a carrier substance that is in a gaseous state under normal atmospheric conditions for conveying the liquid substance to be deposited on the articles, the gaseous carrier being substantially chemically inert with respect to the liquid substance and the article and which process includes the steps of fixing the temperature and relative humidity of the gaseous carrier, dividing the liquid substance into finely divided form in an atomizing chamber, maintaining the temperature of the liquid substance below the boiling point thereof, moving the articles to be treated through a treating chamber, continuously circulating the gaseous carrier in a cycle including a heating chamber to maintain the temperature of the gaseous carrier substantially above the temperature of the articles, the liquid atomizing chamber and the treating chamber, and maintaining a relatively slow velocity of the gaseous carrier in the treating chamber, whereby the liquid substance is converted into a gaseous state, mixed with and carried by the circulating gaseous carrier to the treating chamber wherein it is reconverted to the liquid state and deposited on the surface of the articles on coming in contact therewith.

3. The continuous process for effecting a uniform deposition of hydrofluoric acid over the surface of a series of glass articles for the purpose of etching the glass, which process comprises utilizing a carrier substance that is in a gaseous state under normal atmospheric conditions for conveying the hydrofluoric acid to be deposited on the articles, the gaseous carrier being substantially chemically inert with respect to the hydrofluoric acid and the glass and which process includes the steps of fixing the temperature and relative humidity of the gaseous carrier, dividing the hydrofluoric acid into finely divided form in an atomizing chamber, maintaining the temperature of the hydrofluoric acid below the boiling point thereof, moving the glass articles in continuous succession through a treating chamber, continuously circulating the gaseous carrier in a cycle including successively a heating chamber for heating the gaseous carrier to a temperature substantially above the temperature of the glass articles, the atomizing chamber and the treating chamber, and maintaining a relatively slow velocity of the gaseous carrier in the treating chamber, whereby the hydrofluoric acid is converted into a gaseous state and carried by the circulating gaseous carrier to the treating chamber wherein it is reconverted to the liquid state and deposited on the surface of the articles on coming in contact therewith.

4. The process for effecting a uniform coating of a soluble coating substance upon the surface of an article, which process comprises utilizing a carrier substance that is in the gaseous state under normal atmospheric conditions for conveying the coating substance in finely divided form to the article, the gaseous carrier being substantially chemically inert with respect to the coating substance and the article and which process includes the steps of fixing the temperature and relative humidity of the gaseous carrier, dissolving the coating substance in a liquid solvent, dividing the solution into a finely divided form, maintaining the temperature of the solution below the boiling point thereof, maintaining the temperature of the gaseous carrier substantially above the temperature of the article to be coated, circulating the gaseous carrier to successively bring it into contact with the solution in finely divided form and then into contact with the article, and maintaining a relatively slow velocity of the gaseous carrier past the article, whereby the liquid solution is converted into a gaseous state and carried by the gaseous carrier to the article to be coated whereon it is reconverted to the liquid state and deposited on the surface of the article on coming into contact therewith.

5. The process for effecting a uniform coating of a soluble coating substance upon the surface of an article, which process comprises utilizing a carrier substance that is in the gaseous state under normal atmospheric conditions for conveying the coating substance in finely divided form to the article, the gaseous carrier being substantially chemically inert with respect to the coating substance and the article and which process includes the steps of fixing the temperature and relative humidity of the gaseous carrier, dissolving the coating substance in a liquid solvent, dividing the solution into a finely divided form, maintaining the temperature of the solution below the boiling point thereof, maintaining the temperature of the gaseous carrier substantially above the temperature of the article to be coated, circulating the gaseous carrier to successively bring it into contact with the solution in finely divided form and then into contact with the article, whereby the liquid solution is converted into a gaseous state and carried by the gaseous carrier to the article to be coated whereon it is reconverted to the liquid state and deposited on the surface of the article on coming in contact therewith, and evaporating the solvent from the surface of the article.

6. The continuous process for effecting a uniform coating of a soluble coating substance over the surface of a series of articles which process comprises utilizing a carrier substance that is in a gaseous state under normal atmospheric conditions for conveying the coating substance in finely divided form to the articles, the gaseous carrier being substantially chemically inert with respect to the coating substance and the article and which process includes the steps of fixing the temperature and relative humidity of the gaseous carrier at a predetermined value, dissolving the coating substance in a liquid solvent, dividing the solution into a finely divided form in an atomizing chamber, maintaining the temperature of the solution below the boiling point thereof, moving the articles in continuous succession through a treating chamber, continuously circulating the gaseous carrier in a cycle including successively a heating chamber for heating the gaseous carrier to a temperature substantially above the temperature of the articles in the treating chamber, the atomizing chamber and the treating chamber, and maintaining a relatively slow velocity of the gaseous carrier in the treating chamber, whereby the liquid solution is converted into a gaseous state, mixed with the gaseous carrier and carried to the articles to be coated whereon it is reconverted to the liquid state and deposited on the surface of the articles on coming in contact therewith, and drying the articles to remove the solvent.

7. The continuous process for effecting a uniform coating of a soluble wax over the surface of a series of articles which process comprises utilizing air as a carrier gas for conveying the wax in finely divided form to the articles and

includes the steps of fixing the temperature and relative humidity of the air at a predetermined value, dissolving the soluble wax in a liquid solvent, dividing the solution into a finely divided form in an atomizing chamber, maintaining the temperature of the solution below the boiling point thereof but above the normal room temperature, moving the articles in continuous succession through a treating chamber, continuously circulating the carrier air in a cycle including successively a heating chamber for heating the carrier air to a temperature substantially above the temperature of the articles in the treating chamber, the atomizing chamber and the treating chamber, and maintaining a relatively slow velocity of the carrier air in the treating chamber, whereby the liquid solution is converted into a state following the action of gases, mixed with the carrier air and carried to the articles to be coated whereon it is reconverted to the liquid state and deposited on the surface of the articles on coming in contact therewith, and evaporating the solvent from the surface of the articles.

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