VAPOR COATING EMPLOYING DEGASSING OF COATING METAL

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Filed June 25, 1964, Ser. No. 378,021

14 Claims. (Cl. 117—107)

ABSTRACT OF THE DISCLOSURE

An apparatus and method for vapor coating metallic materials on a substrate wherein the material to be coated on the substrate is melted outside an evacuated coating chamber, and then conveyed to a vessel within the chamber for vaporization.

This invention relates to a vapor coating apparatus and method, and more particularly, to apparatus and method for vapor deposition of metallic coating materials on a substrate.

Vaporization of coating material within an evacuated chamber and condensation of the vapors on a substrate has been proposed heretofore. Such structure is fairly well known to those skilled in the art and generally provides for introduction of coating material to a boat disposed within the evacuated chamber. The coating material is generally vaporized within the boat.

An improvement over such known devices is set forth in a copending application Ser. No. 313,658, now abandoned, filed on Oct. 3, 1963, and entitled Vapor Coating Apparatus and Method. In said application, it is pointed out that numerous advantages are attained when the material to be coated is rendered molten in a vessel outside of the evacuated chamber and then conveyed to the boat within the chamber. The present invention likewise utilizes a vessel for the coating material disposed outside of the evacuated chamber. Prior to conveying the coating material into the evacuated chamber for directing vaporized coating material toward a substrate, the coating material is degassed. The coating material may be metallic material such as zinc, tin, aluminum, etc., or may be non-metallic in nature. Coating material, especially metal, generally has gases therewithin which should be removed before the coating material is vaporized.

When the coating material has not been degassed prior to being vaporized, the release of the gases during the vaporization of the coating material under vacuum results in small bursts. These small bursts often result in the coating material being splashed on the environment surrounding the boat or other vapor directing means disposed within the evacuated chamber. By degassing the coating material prior to directing the same into the evacuated coating chamber, the above-mentioned bursts are eliminated and thereby render the coating action more uniform. As a result thereof, higher speeds may be attained for the substrate to be coated.

It is an object of the present invention to provide a novel vapor coating apparatus.

It is another object of the present invention to provide a novel vapor coating method.

It is another object of the present invention to degas the coating material before it is vaporized and directed toward a substrate.

It is another object of the present invention to provide a vapor coating apparatus and method which eliminates the problem of gas bursts resulting from gas dissolved in the molten coating material to be condensed on a substrate.

It is another object of the present invention to provide a coating apparatus and method wherein degassed vaporized coating material is conveyed to an evacuated coating chamber for condensation on a substrate.

Other objects and advantages of the present invention will become apparent hereinafter.

For the purposes of illustrating the invention, there are shown in the drawings forms which are presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIGURE 1 is a diagrammatic sectional view of one embodiment of the present invention.

FIGURE 2 is a partial view of apparatus similar to FIGURE 1 but directed to another embodiment of the present invention.

FIGURE 3 is a diagrammatic sectional view of another embodiment of the present invention.

Referring to the drawing in detail, wherein like numerals indicate like elements, there is shown in FIGURE 1 a diagrammatic illustration of one embodiment of the present invention wherein the apparatus is designated generally as 10.

The apparatus 10 comprises a coating housing 12 having substrate guide means such as driven roller 14 disposed therewithin. Roller 14 is driven by a motor 16. Disposed within the housing 12 there is provided a boat 18 having heating coils associated therewith. A pump 20 is provided for evacuating the interior of the housing 12. A substrate 22 is adapted to be unwound from a reel within the housing 12 and wound around the roller 14. Substrate 22 may be a strip of metal, paper, polymeric resin, etc. Alternatively, the substrate 22 may enter the housing 12 through a seal in one wall and exit through a seal in another wall of the housing 12.

A conduit 24 enters the housing 12 and is in communication at one end with the interior of the boat 18. Conduit 24 may be provided, externally of the housing 12, with a control valve 26 and a coupling 28. When complete advantage of the full barometric height is taken, valve 26 may be eliminated. The other end of the conduit 24 communicates with the interior of a vacuum chamber 30. Chamber 38 is adapted to be evacuated by a pump 32 which communicates with the housing 38 at a point disposed to one side of a baffle 34. To minimize loss of vapors and prevent vapor entrainment in the pumping system, a suitable condenser 33 may be provided between pump 32 and chamber 30. An inlet leg 38 communicates with the housing 30 on the opposite side of the baffle 34. A floor 36 in the housing 30 may slope from the point where the inlet leg 38 communicates therewith to the point where the conduit 24 communicates therewith. Any suitable structure or orientation may be provided to drain molten metal from conduit 24 and/or chamber 30 when the apparatus 10 is to be shut down for a period of time after operation of the same.

The leg 38 extends downwardly into the molten coating material 42 disposed within a vessel 40. The coating material 42 may be rendered and maintained in a molten state by means of a heater 44 disposed below the vessel 40. The coating material may be metallic in nature such as zinc, tin, etc. Alternatively, the coating material 42 may be a non-metallic material such as a polymeric resin, photographic emulsions, etc.

The level of the molten coating material 42 may be automatically controlled within a predetermined range or an alarm system may be provided to give an indication that the level of the coating material 42 has fallen below a predetermined level. Such alarm system may include a float 46 having a contact actuator 50. The float and its actuator may be guided for vertical movement by a bracket 48 coupled to the vessel 40. When the level of the coating material 42 falls below a predetermined level, the contact...
actuator 50 will close switch 52 thereby completing a circuit from the battery 54 to the alarm 56. The alarm 56 may be visible or audible thereby signalling the need for introduction of more coating material into the vessel 40. It will be appreciated that other types of liquid level alarm systems may be provided. For example, spaced electrodes may be placed within the coating material, the distance between them being given when the uppermost electrode is exposed.

The operation of the apparatus 10 is as follows:

The coating material 42 disposed within the vessel 40 will be exposed to atmosphere. Hence, removal of slag from the surface of the coating material may be accomplished by utilizing the continuously coating action on the substrate 22. Vacuum pump 32 draws molten coating material 42 into the housing 30. The coating material is then exposed to an evacuated atmosphere which removes gases from the coating material as the coating material flows along the bottom wall 36 of the housing 30. Thereafter, the degassed coating material is conveyed to the boat 18 wherein it is evaporated and condensed on the substrate 22. Due to the pressure differentials, the housing 30 and vessel 40 may be disposed below the level of the coating material within the boat 18.

The apparatus 10 may also be aided by utilizing gravity whereby housing 30 may be higher than the boat 18. The pressure differential will decrease as the level of the coating material 42 decreases within vessel 40.

When the level of the coating material 42 falls below a predetermined level, float 46 will descend thereby unlocking contact actuator 50 which closes switch 52. Thereafter, alarm 56 will alert operators to the fact that more coating material must be introduced into vessel 40. The heater 44 will render the coating material molten and maintain the coating material in a molten state within the vessel 40. Adjustment of valve 26 may be utilized to vary the flow rate of coating material. In order to prevent undue condensing of the coating material, conduit 24 may be insulated and/or provided with electrical heaters as desired.

In FIG. 2, there is illustrated an apparatus designated generally as 60. Apparatus 60 is identical with apparatus 10 except as otherwise specified.

Coating material 75 is rendered molten and maintained in a molten state in vessel 72 by a heater 74. A vacuum chamber 62 is supported in a convenient manner above the vessel 72. Chamber 62 has an inlet leg 68 and an outlet leg 70 each of which communicate with the molten material 75 below the surface level thereof. A baffle 66 is provided within the housing 62 opposite the portion wherein leg 68 communicates with chamber 62.

On opposite side of the baffle 66, a vacuum pump 64 communicates with the interior of vacuum chamber 62. Circulation of coating material 75 up leg 68, through chamber 62, and down leg 70 may be accomplished in any convenient manner. Circulation can be made more positive by a gas lift means or by an induction pumping coil inducing an alternating flux in one or both legs. An alarm system may be provided as described above.

The apparatus 60 operates in the same manner as described above. The coating material 75 will be continuously recirculated into the chamber 62 wherein the coating material will be degassed and then returned to the vessel 72. From the vessel 72, the degassed coating material 75 will be conveyed by way of conduits 76 and 24 to the housing 62. In view of the above description of apparatus 10, further description of apparatus 60 is not deemed necessary.

In FIGURE 3, there is illustrated another embodiment of the present invention designated generally as 80. The apparatus 80 is generally similar to the embodiments described above in that coating material will be degassed before it is introduced into the evacuated coating chamber. Thus, coating material 86 is rendered molten and maintained in a molten state within vessel 82 by heater 84. A vacuum chamber 88 is supported in a convenient manner above the vessel 82. An inlet leg 91 communicates with the interior of vacuum chamber 88. The other end of leg 91 is disposed below the surface level of the coating material 86.

Vacuum chamber 88 is adapted to be evacuated by pump 90. A baffle is disposed between the pump 90 and the inlet leg 91. The coating material 86 is degassed within the vacuum chamber 88 and the vessel 82 with a weir 92, through conduit 93 into boiler 94. The degassed coating material is then vaporized within boiler 94 and discharged from the same in a vaporized or superheated state through conduit 95 having a control valve 96 therein. Conduit 95 communicates with a manifold having a plurality of discharge nozzles 98, each of which may be heated to further superheat the coating material 86.

The manifold 97 is disposed within an evacuated housing 100 having a coating chamber therewith. A roller 104 within the housing 100 is driven by a motor 102 and guides the substrate 99 which passes or moves over the nozzles 98.

The apparatus 80 enables the thickness and pattern of the coating material condensed on the substrate 99 to be controlled very accurately. Thus, very thin layers of coating material may be accurately condensed on the substrate. For example, the condensing fact that the coating material is vaporized outside of the coating chamber and discharged by nozzles 98 which are of the type which discharge the vaporized coating material in the form of a mist. Also, when the coating material 86 is a metal such as zinc, the slag will remain within the vessel 82. Thus, it is possible to control, by the structural interrelationship of apparatus 80. Thus, apparatus 80 enables a substrate to be coated uniformly at high rates of speed.

In each of the embodiments described above, the coating material is rendered molten by a heater disposed within the outside vessel, then degassed, and then conveyed to means within the coating chamber for directing vaporized coating material at the substrate. As pertains to apparatus 10 and 60, the delivery of preheated coating material to the boat 18 reduces the thermal shock thereon and enables the boat 18 to be made smaller and of cheaper materials.

It is within the scope of the invention to convey the molten coating material to chamber 30 or 88 by a means other than a barometric leg. Thus, the coating material could be conveyed to said chambers by gravity or positive pumping with suitable valves or the like to control flow. The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

We claim:

1. A coating method comprising the steps of heating metal in a vessel exposing, to a temperature above its melting point, the melted metal to vacuum in a first evacuated housing until the molten metal is degassed, moving the degassed molten metal to a second evacuated housing, vaporizing the degassed molten metal in said second housing, moving a substrate in said second housing and condensing the vaporized degassed molten metal on said substrate within said second housing.

2. A coating method comprising the steps of melting metal in a vessel, introducing heat into the metal to maintain the same in a molten state, moving the metal in a molten state through an air-evacuated chamber until the molten metal is degassed, vaporizing the degassed molten metal, after transference to a second evacuated chamber and condensing the vaporized degassed molten metal on a substrate which is disposed within the second evacuated chamber.

3. A method in accordance with claim 2 including the step of sensing the level of molten metal in said vessel, and generating a signal when the level of the metal falls below a predetermined point.
4. A method in accordance with claim 2 wherein the step of vaporizing the metal is accomplished by discharging the vaporized degassed metal through nozzles directed toward the substrate.

5. A method in accordance with claim 2 wherein said step of degassing the metal includes withdrawing molten metal from the vessel and returning degassed molten metal to said vessel.

6. Apparatus comprising a housing having a coating chamber, means for supporting a substrate in said chamber, means for evacuating said chamber, means within said chamber for directing vaporized coating material at the substrate, a vessel outside said chamber and in communication with said vapor direct ing means, said vessel being adapted to support molten coating material there within, and means for degassing the coating material before the coating material is conveyed to said vapor directing means.

7. Apparatus in accordance with claim 6 wherein said vapor degassing means has an inlet leg extending into said vessel.

8. Apparatus in accordance with claim 7 wherein said degassing means includes a vacuum chamber, and means for evacuating said vacuum chamber.

9. Apparatus in accordance with claim 6 including liquid level responsive means associated with said vessel for generating a signal as a function of the level of coating material within said vessel.

10. Apparatus in accordance with claim 6 wherein said vapor directing means is a nozzle within said coating chamber, and means outside of said coating chamber for vaporizing the coating material, said last mentioned means being in communication with said nozzle and with said vessel.

11. Apparatus in accordance with claim 6 including means outside of said housing for vaporizing the coating material, said means for degassing the coating material being connected to said vaporizing means, a manifold within said coating chamber, a plurality of discharge nozzles on said manifold, and conduit means connecting said vaporizing means with said manifold and with said vessel.

12. Apparatus in accordance with claim 6 wherein said degassing means is structurally interrelated with said vessel to return the degassed coating material to said vessel.

13. Apparatus comprising a housing having a coating chamber, means for evacuating said chamber, means within said chamber for directing vaporized coating material at an element to be coated, a vessel outside said chamber, means providing fluid communication between said vessel means and vapor directing means, said fluid communication means including means for degassing the coating material before it is introduced to said vapor directing means, and means for causing the coating material to flow from the vessel means to the vapor directing means.

14. Apparatus in accordance with claim 13 including means for vaporizing the degassed coating material before it is introduced into the vapor directing means.

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