Nov. 25, 1958 P. R. HENDRIXSON 2,861,897

METHOD OF APPLYING AN ORGANIC FILM COATING BY SPRAYING

Filed Jan. 13, 1955 3 Sheets-Sheet 1

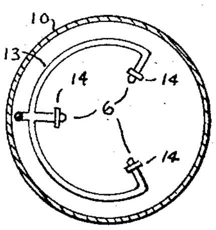

FIGURE 2

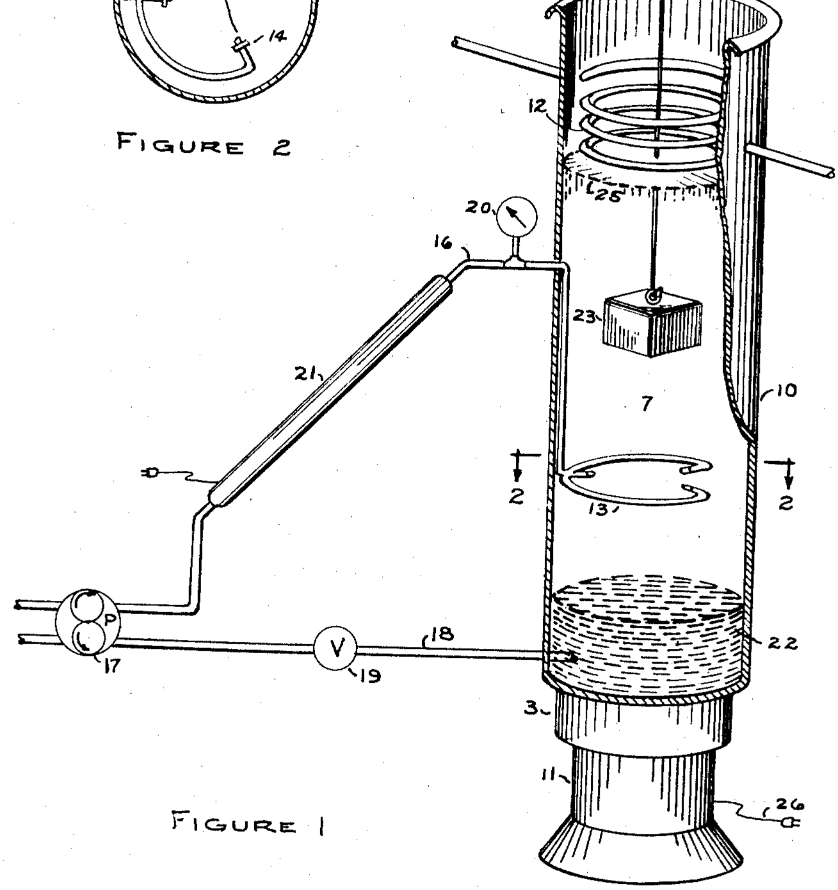

FIGURE 1

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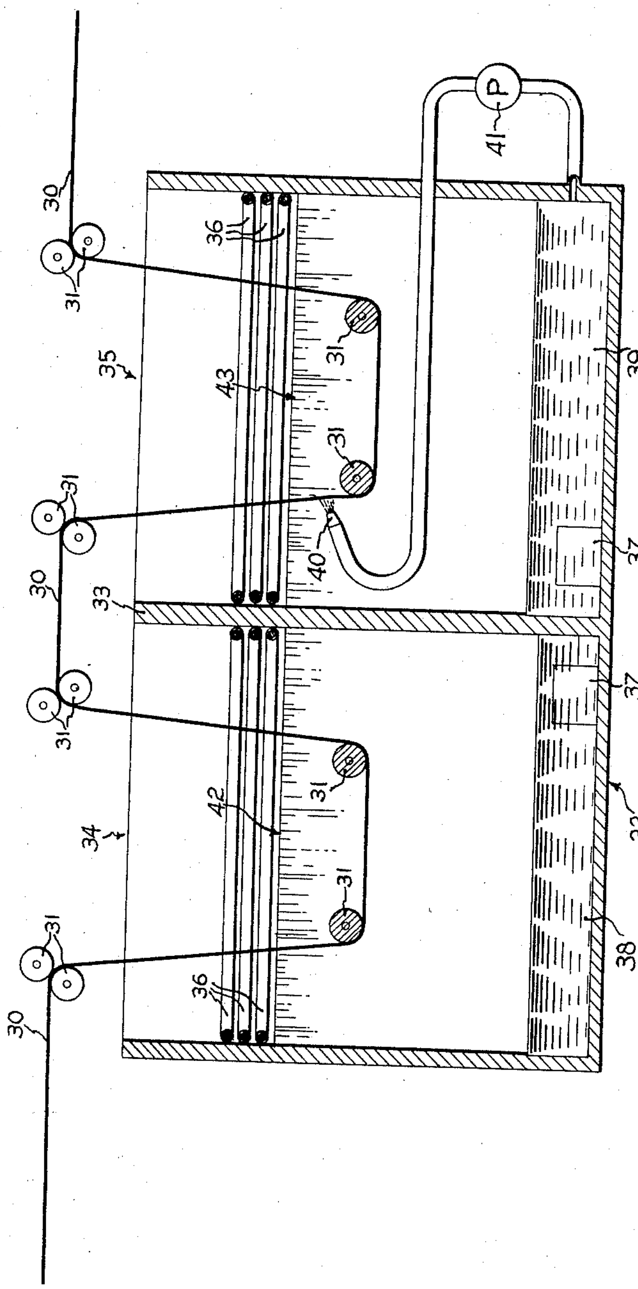

FIGURE 3

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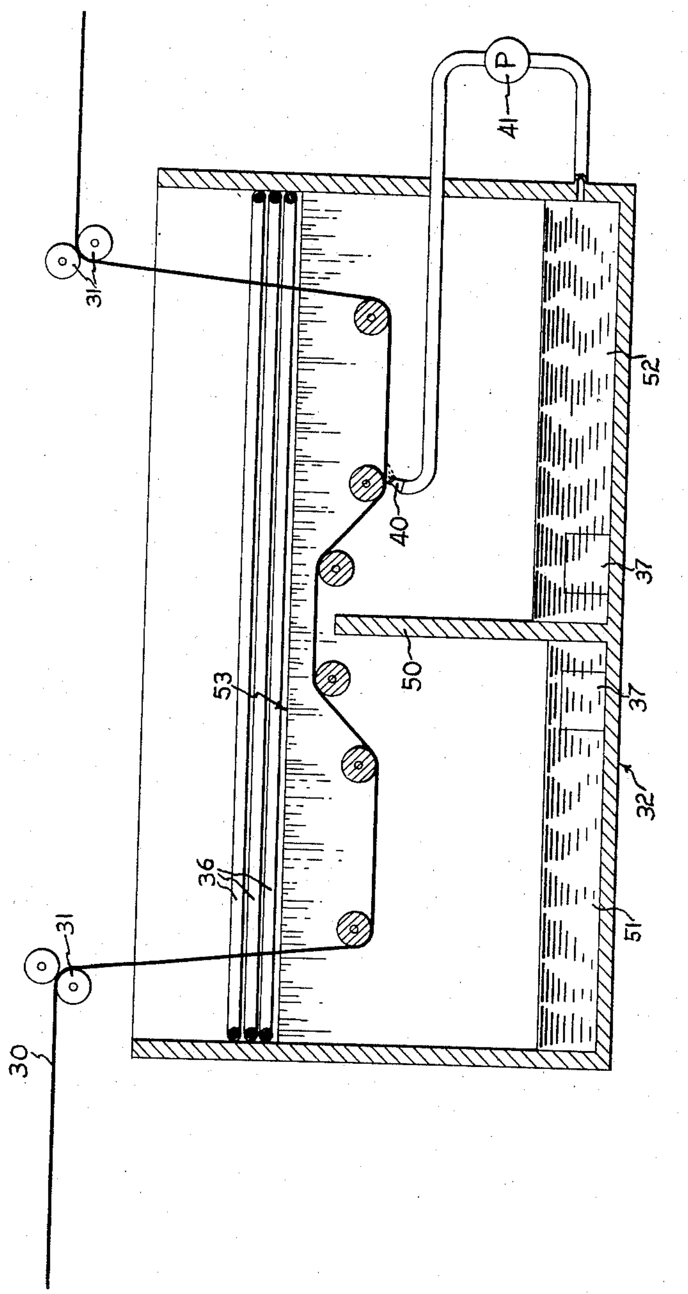

FIGURE 4

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United States Patent Office

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METHOD OF APPLYING AN ORGANIC FILM COATING BY SPRAYING

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Application January 13, 1955, Serial No. 481,617

20 Claims. (Cl. 117—47)

This invention relates to coating objects, particularly metallic objects, by means of a coating composition dissolved in a relatively low-boiling solvent.

Heretofore, various methods have been employed to establish decorative or protective coatings on metallic workpieces. Painting, spraying and dipping are well-known examples of these methods. Solvents or thinners are frequently necessary in such processes and, when used, contribute greatly to the cost thereof since they are generally lost through evaporation. Losses of the coating compound in the conventional processes are also high because of drippage, drag-out, and the like.

One method of avoiding some of the losses generally encountered in applying coatings is found in Borushko U. S. Patent 2,515,489. In this patent a process is disclosed in which a workpiece is dipped into a liquid comprising a volatile solvent carrying a film-forming material dispersed therein. The liquid is maintained at an elevated temperature approaching the boiling point of the solvent. The workpiece is allowed to remain in the liquid until it becomes warm and then is withdrawn into a drying zone above the liquid where the solvent is evaporated.

The Borushko process described eliminates many of the difficulties inherent in the prior art but introduces problems of its own. Heating the workpiece in the solvent, for example, requires time and ties up the painting chamber for a longer period than is desirable. Drying the metallic article above the liquid also requires time and lengthens the period during which the painting chamber is tied up. Furthermore, when the dip method is used, especially in conjunction with a heating process, there is little control of the thickness of coating that can be produced. Changing the viscosity of the coating solution as by thickening or diluting it is essentially the only method available for this control. Such inflexibility may be quite undesirable when it is necessary to alternate the thickness of coatings applied between one workpiece and the next. In addition, the depth of liquid needed to cover a given article may be so great as to require an undue amount of expensive solvent.

An over-all object of the present invention is consequently provision of a new and useful process for applying protective and decorative coatings to workpieces. A second object is provision of a process for coating a workpiece with a dissolved film-forming material in which the solvent can be dried very rapidly. Another object is provision of a method for coating selected articles by means of a dissolved composition in which the coating and the solvent-drying steps are combined. Yet another object of the invention is provision of a process for coating articles in which the thickness of the coat applied can readily be controlled. Other objects will be apparent hereinafter.

The invention comprises essentially the following two steps: a workpiece is first preheated to at least the boiling temperature of a selected volatile solvent and is then sprayed with a film-forming material dissolved in the volatile solvent and simultaneously dried or freed of solvent by means of the heat it contains. Two major embodiments of the process differ in the method of preheating employed. In one method, the workpiece is preheated in a separate heating vessel and then transferred to a spray chamber. In another method, preheating is accomplished in the hot vapors immediately above the boiling solvent mixture. Preheating and spraying are accomplished in either a discontinuous or continuous manner.

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Apparatus wherein the invention may be accomplished is illustrated by the appended drawings, in which:

Figure 1 is an elevation of a spraying device convenient for accomplishing the discontinuous process described, part being cut away to expose internal construction;

Figure 2 is a plan of the sparger as seen from line **2—2** of Figure 1; and

Figures 3 and 4, in which the same numeral represents the same part, are sectional plans of apparatus used in the continuous embodiment of the invention.

Figure 1 shows an upright column, open to the atmosphere, comprising a hollow, vertical shell **10** mounted on pedestal **11**. The column is disclosed as of circular cross-section but square or other cross-sections are equally serviceable. Near the top of shell **10** is positioned cooling coil **12** while within it is fixed sparger **13**. Sparger **13** (Figure 2) is depicted with three spraying heads **14** but other conventional types of sprayer may also be used. Preferably, these spraying heads are adjustable as by conventional swivel joints for greater flexibility in operation. Adjustment may be made through external connections (not shown) or by hand. A fluid connection extends from sparger **13** through pipes **16** and **18** and pump **17** to the lower part of shell **10**. Valve **19**, pressure gauge **20** and heater **21** may be provided in the elements of this fluid connection as desired. A heater, of which electrical inlet **26** only is shown, is also provided in pedestal **11** in heat-conductive contact with the bottom of the interior of shell **10**.

The operation of the apparatus of Figure 1 is very simple. In the shell is placed a mass **22** of a coating formulation. This coating formulation will generally consist of a film-forming substance dissolved or dispersed in a volatile solvent such as trichlorethylene or perchlorethylene. Cooling coil **12** and the heater in pedestal **11** are turned on. The coating formulation is boiled and solvent vapor rises in the shell **10** to form an air-vapor interface **25** at or near the bottom of the cooling coil.

If it is so desired, workpiece **23** may be preheated to or above the boiling point of the volatile solvent in a heater outside the spraying chamber. It is then transferred as by wire **24** into the vapor in shell **10**. For best results the spraying heads **14** of sparger **13** should be directed onto the workpiece. The space within which the spraying is accomplished, i. e., between the solvent mass and the cooling coils, may be termed the "spray zone."

Preheating may alternatively be carried out in the spray zone itself. In this case, the cold workpiece **23** is lowered through the spray into the hot vapors immediately above the boiling coating formulation. The spray may be stopped while the workpiece is being lowered or preheated in the solvent vapors, but the stoppage is unnecessary. When the heating is accomplished the workpiece is raised into the spray. The heat source utilized for the solvent in such instances should be large enough to supply all the heat requirements of the workpiece without depressing the vapor line in the spray chamber. Some time will be lost in heating the workpiece according to this second embodiment but a special piece of equipment will not be required therefor.

After the workpiece **25** has been preheated by either of the methods described, it is positioned with relation to the sparger. It is then sprayed with liquid transported through pump 17 and the fluid connection from the liquid mass 22 to the sparger. The volatile solvent evaporates or flashes off as it contacts the preheated workpiece producing an article that is dry but covered with a protective or ornamental film. When the film has reached the desired thickness, the article is withdrawn directly into the atmosphere. If the workpiece is withdrawn at too great a speed, air-vapor interface 25 will be disturbed. A disturbance of this interface may disperse toxic solvent into the work area and hence should be avoided.

In Figure 3 is shown a continuous conveyor or belt 30 guided by rollers 31 through tank 32. Tank 32 is divided by partition 33 into first and second compartments 34 and 35. At the top of each compartment are cooling coils 36 and in each is a heater 37. Perchlorethylene 38 or other relatively high boiling liquid is placed in compartment 34 and the paint-solvent mixture in compartment 35. When the heaters are turned on perchlorethylene-air and trichlorethylene-air interfaces 42 and 43 form at the bottom of the coils as indicated. Pump 41 is provided to convey the paint-solvent mixture to sparger 40. Articles to be sprayed are placed on the belt 30 and conveyed through hot perchlorethylene vapors in compartment 34 where they are heated. They then pass into the hot trichlorethylene vapors in compartment 35 and are sprayed. After they are sprayed they are moved out of the apparatus and are taken from the conveyor.

Figure 4 shows an apparatus much like that of Figure 3. Here, however, partition 50 is quite low and liquid 51 is the solvent, e. g., trichlorethylene, used in coating composition 52. There results a single air-vapor interface 53 below which the article being treated is kept during both the preheating and spraying steps.

Certain features and operational variables of the invention should be noted with respect to all embodiments. Thus the process combines a degreasing operation with the formation of a coating. This result follows when a degreasing solvent such as trichlorethylene or perchlorethylene is chosen as the preheating medium. Condensation of this solvent on the cold article and subsequent drippage removes any grease present. Removal of the grease produces a clean surface receptive to the paint or other material applied in the succeeding step of the process. Degreasing is, of course, accomplished when the workpiece is preheated in the spray chamber as well as when it is carried out in a separate step. To avoid the build-up of grease in the paint mixture, clean workpieces only should be preheated directly in the vapors from the mixture. It may be noted, in fact, that except for the presence of paint or other film-forming substance in the solvent, conditions utilized during this process are substantially those of conventional degreasing.

The temperature to which the workpiece is preheated is not sharply critical so long as it is at least as high as the boiling point of the volatile solvent chosen. If the temperature of the workpiece falls below this boiling point, solvent condenses on it and removes paint. The higher the preheat temperature, moreover, the more efficiently the drying is accomplished. Consequently, temperatures above the boiling point of the solvent are preferred. One method of heating the article to a relatively high temperature or "superheating" it is to contact it with the heated vapor of a liquid boiling at a temperature higher than the boiling point of the solvent employed in the coating composition. Figure 3, for example, shows perchlorethylene, a good degreasing solvent boiling at 121.2° C. at 760 mm. of mercury pressure, used to preheat and degrease a workpiece subsequently coated with a film-forming material dissolved in trichlorethylene, a solvent boiling at 86.9° C. Methylene chloride, boiling at about 40° C., other chlorinated hydrocarbons and mixtures thereof and still other dense solvents can be substituted in this sequence as desired. The density of the solvent employed is quite important since solvents of relatively low specific gravity will produce wavering air-vapor interfaces.

The same result of superheating can follow, though less obviously and to a lesser extent, when the workpiece is contacted with the vapors immediately above the boiling coating formulation. Since this composition contains at least some dissolved matter, its boiling point and the temperature of the evolved vapors will be above that of the pure solvent. It is, of course, impossible that two solvents be employed sequentially when the second method of heating is selected. The workpiece may also be heated directly, i. e., without the use of any solvent, but such heating loses the advantage of a degreasing operation.

The temperature of the coating composition sprayed on the workpiece is likewise not sharply critical. It need not be as high as the boiling point of the solvent to produce rapid and good drying. With trichlorethylene, a preferred solvent, temperatures between about 50° and 85° C. can be used, around 70–85° C. being preferred at atmospheric pressure. Since the rate of drying depends on the temperature, it is actually desirable that both the workpiece and the spray contacting it be as hot as possible. Hot workpieces can, of coures, be successfully treated with colder spray than can relatively cold workpieces.

The temperatures of the preceding paragraph apply to the coating solution as it is sprayed onto the workpiece. The liquid in the bottom of the upright column should be kept boiling, particularly where preheating in the spray zone is employed. Vigorous boiling is preferred because it insures production of a steady interface, thus preventing admixture of the solvent with air and loss of the former, and helps to obviate condensation on the workpiece. Heat losses generally occur during the transfer of the coating composition to the sparger and account for the lowered temperature in the spray itself.

The time required for preheating is in general that necessary for the workpiece to come to a temperature equilibrium with the vapors contacted. Equilibrium is particularly important where preheating in the spray chamber is utilized since in this case the maximum temperature available is, at most, only a few degrees above the boiling point of the solvent.

The time required for the actual spraying step can vary to some extent. Where a thin coating only is desired, a rapid single passage of the preheated workpiece through the spray is usually sufficient. Additional passes or suspension of the workpiece in the spray for a short time can be employed to obtain thicker coatings. Spraying should not, however, be prolonged after the temperature of the workpiece falls below the boiling point of the solvent. As noted above, condensation of solvent vapor may then result, producing a degreasing effect removing paint from the article treated.

The paints and other coating compositions adapted for application as described vary widely. Choice of paint or other film-forming material will be determined by the utility for which it is intended, by the color desired and by other factors. It must, of course, be able to produce either a solution or a suspension in the solvent chosen. Asphalt-based paints are particularly valuable for this purpose. One satisfactory film-forming material is "Luxall" Core Black Paint PNR 352–60, a special asphalt-based paint sold as a 50% (by weight) solution in trichlorethylene by the National Manufacturing Company of Tonawanda, New York. Coatings which may be sprayed include, however, varnishes, lacquers, enamels, waxes and the like in addition to paints.

The concentration of the film-forming material dissolved in the solvent will depend on the nature of the film-forming material, on the solvent, on the thickness of covering desired and on the heating capacity available. The "Luxall" paint may be used in a 10–25% solution in trichlorethylene, 12.5–15% being quite satisfactory.

Higher percentages can be used to raise the boiling point of the paint-solvent mixture and expedite the drying of the sprayed workpiece.

It will be evident that the process and apparatus of this invention may be used to coat any solid material which is insoluble in the solvent used. Metallic articles in particular can be treated as described. Thus, protective or maintenance coatings can easily be applied to automotive parts such as radiators, frames, differentials and the like. Other base materials can, however, also be treated by spraying by the process of this invention.

Additional variables will be apparent to those skilled in the art. Thus the pressure at which the coating suspension or solution is pumped to the workpiece may be changed as desired, varying to some extent with the size of the nozzles of the sparger and the concentration and viscosity of the composition sprayed. The rate of liquid flow is also largely a matter of choice, depending on such factors as concentration of dissolved film-forming material and the thickness of coating desired.

The advantages of the process in general parallel the objects named above. Some may, however, be specifically mentioned:

(1) The completely closed system utilized eliminates the need for expensive devices for reclaiming paint and solvent;

(2) Control of the pump can vary the thickness of the coating at the will of the operator;

(3) Combining degreasing and painting operations eliminates the need for a separate degreasing step;

(4) The spray heads or nozzles can be adjusted and concentrated in one area without fear of losses due to over-spray, thus facilitating the spraying of intricate parts;

(5) The non-inflammable solvent effectually seals the paint from contact with air and thus minimizes flammability hazards; and

Since the process employs liquid only to provide a reservoir of film-forming material and not to cover a bulky immersed workpiece, it also minimizes floor loading.

There follow some examples of the operation of the process. In these examples all percentages are by weight.

Example 1

One gallon of "Luxall" Core Black Paint PNR 352–60 was diluted to a volume of two gallons with trichlorethylene. The resulting mixture was then placed in a spraying tank of the type shown in Figure 1 and heated to its boiling point. The circumferential cooling coils condensed the vapors of the solvent and returned the condensate to the boiling solvent.

A section of an automobile radiator core, preselected as the workpiece, was suspended in the vapor of boiling perchlorethylene until it reached the temperature of the latter. Preheating was accomplished in such a manner that a minimum amount of solvent collected in the interstices of the radiator core section. The workpiece was then transferred to the spray-painting chamber containing the boiling trichlorethylene-paint mixture.

Pumping of the paint-solvent mixture was carried out at a spray temperature of about 50° C. The pressure was 25 pounds per square inch gauge and the flow rate of liquid was 0.132 gallon per minute. The preheated workpiece was passed through the spray and removed from the painting chamber uniformly coated with the paint. The coating was free of solvent and dry to the limit of the tackiness of the paint. In less than one minute the workpiece was cooled and the paint had hardened. All of the interstices in this complex automobile radiator core section were penetrated by the paint to a minimum depth of ½ inch.

The run with the radiator core was later substantially repeated with a flat brass plate as the workpiece. Successful painting was readily accomplished, the plate being dried practically on contact with the spray.

Example 2

Example 1 was essentially repeated with trichlorethylene vapor as the preheating medium and a sheet of a commercial plastic as the workpiece. The plastic was heated in the vapors of boiling trichlorethylene and then transferred to the spray chamber. The solvent-paint mixture was sprayed at a pressure of 35 pounds per square inch and 0.127 gallon per minute and a spray temperature of 50° C. The workpiece was removed from the paint chamber covered with a continuous coating of solvent-free black paint which hardened to a non-tacky finish in 10 to 15 minutes.

Example 3

A piece of radiator core similar to that of Example 1 was suspended for a few minutes in the hot vapors immediately above the center of a "Luxall" paint-trichlorethylene mixture of about 10% concentration boiling in the apparatus of Figure 1. The workpiece was then withdrawn from the apparatus, rather slowly, in a single pass through the spray into the atmosphere. The core was covered with paint and seemed to be dry upon initial inspection except for a small amount of solvent condensed in its interior.

Repetitions of this experiment with the temperature of the spray at 70° C. or above and the temperature of the workpiece at about the boiling point of trichlorethylene or above completely eliminated condensation of the solvent in the radiator core. The workpiece could be drawn through the spray quite rapidly and emerge perfectly dry but painted uniformly.

Having described my invention, I claim:

1. The method of applying a film-like organic coating to the surface of an article which comprises providing (1) a body of a liquid composition including a volatile solvent and a film-forming organic material dispersed therein, said solvent being substantially inert to the film-forming organic material, and (2) a spray zone in fluid communication with said body for retaining the vapors of the solvent; maintaining said liquid composition at its boiling temperature; condensing solvent vapors in the spray zone and returning the condensed solvent to the body of liquid; preheating the article to be coated to a temperature at least equal to the boiling point of the solvent; spraying said article in the spray zone with said liquid composition, the heat within the article evaporating the solvent as the composition is applied; and withdrawing the article from the spray zone substantially solvent-free but coated with said film-forming organic material.

2. The method of claim 1 in which the article to be coated is preheated within the spray zone before it is sprayed.

3. The method of claim 2 in which the solvent is a chlorinated hydrocarbon.

4. The method of claim 1 in which the article to be coated is preheated before introduction into the spray zone.

5. The method of claim 4 in which the solvent is a chlorinated hydrocarbon.

6. The method of claim 5 in which the chlorinated hydrocarbon is a member of the group consisting of methylene chloride, trichlorethylene and perchlorethylene.

7. The method of claim 4 in which the article is preheated in the boiling vapors of a first chlorinated hydrocarbon having a boiling point above that of a second chlorinated hydrocarbon chosen as the solvent.

8. The method of claim 7 in which the first chlorinated hydrocarbon is perchlorethylene and the second is trichlorethylene.

9. The method of claim 7 in which the first chlorinated

hydrocarbon is trichlorethylene and the second is methylene chloride.

10. The method of coating a workpiece with a selected coating material which comprises (1) providing a dispersion of said coating material in a volatile solvent substantially inert to the coating material, (2) maintaining said dispersion at the boiling point thereof, (3) preheating said workpiece to at least substantially the boiling temperature of said volatile solvent, (4) spraying the hot dispersion onto the preheated workpiece, and (5), substantially on contact with the workpiece, volatilizing off substantially all of the solvent from the dispersion sprayed onto the workpiece, leaving thereon a coating of the coating material.

11. The invention of claim 10 in which the solvent is a chlorinated hydrocarbon.

12. The invention of claim 11 in which the solvent is trichlorethylene.

13. The invention of claim 11 in which the solvent is perchlorethylene.

14. The invention of claim 10 including the additional step of recovering the solvent volatilized off the workpiece.

15. In a process of coating a workpiece by spraying thereon a hot dispersion of a coating material in a volatile solvent substantially inert thereto, the step of preheating said workpiece before spraying the same to at least the boiling point of the volatile solvent but below the decomposition temperature of the coating material whereby volatile solvent in the dispersion is evaporated when the spray strikes the preheated workpiece and is thus prevented from affecting the coating on the workpiece.

16. The invention of claim 15 in which the solvent is a chlorinated hydrocarbon.

17. The invention of claim 16 in which the solvent is trichlorethylene.

18. The invention of claim 16 in which the solvent is perchlorethylene.

19. The invention of claim 15 including the additional step of recovering the solvent volatilized off the workpiece.

20. The invention of claim 15 wherein the spraying takes place with the vapors evolved from said hot dispersion.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,861,897 November 25, 1958

Philip R. Hendrixson

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 8, line 16, for "with" read -- within --.

Signed and sealed this 3rd day of March 1959.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents