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ONE STEP METHOD FOR REMOVING WATER-INSOLUBLE COATINGS APPLIED TO A SUBSTRATE

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No Drawing. Continuation-in-part of abandoned application Ser. No. 228,380, Feb. 22, 1972. This application Apr. 12, 1973, Ser. No. 350,401

Int. Cl. B08b 7/00

U.S. Cl. 134—4 37 Claims

ABSTRACT OF THE DISCLOSURE

Water-insoluble coatings, such as paint and the like, are effectively removed from spray masks and other substrates by applying to the surface of the substrate an aqueous solution of a film-forming material; drying the solution to form a film; and after subsequent use, when paint or the like has accumulated on the coated mask, immersing the substrate in a heated bath of the same aqueous solution, thereby removing the paint therefrom and concurrently redepositing the film onto the surface of the substrate.

Relationship to Other Patent Applications

This application is a continuation-in-part of my prior application Ser. No. 228,380 filed Feb. 22, 1972, and now abandoned.

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention pertains primarily to decorative coating operations. More particularly, the present invention concerns the use of spray masks and similar substrates and the removal of paint therefrom and even more particularly to certain compositions and methods used in such operations.

II. Description of the Prior Art

In the decorative painting art, a paint spray mask having accurately formed openings is positioned adjacent the workpiece which is to be painted. The openings in the mask define the areas of the workpiece surface which are to be painted. Paint is applied to the workpiece surface by use of a spray gun or the like, and after a number of workpieces have been painted, producing an accumulation of paint on the paint spray mask, the latter must be cleaned.

A number of methods have been developed to remove the paint from such paint spray masks. The most common method employed is to spray the painted masks with a solvent, such as a chlorinated hydrocarbon, a ketone or an aromatic hydrocarbon. While the use of such solvents is effective, such use is characterized by several disadvantages. The more volatile solvents represent a fire hazard, while others are toxic. Further, such solvents not only represent a high initial investment, but they tend to increase cleaning costs as solvents must be constantly replenished because of evaporation losses. It has also been extremely difficult to dispose of solvent paint cleaning residues since they may not be disposed of through septic fields or sanitary sewers. Disposing of such residues thus represents an additional expense in the use of such solvent systems.

To avoid solvent-type systems, it has been suggested that a wax or similar emulsion be applied to the paint spray mask. The emulsion is sprayed on the mask and allowed to dry and solidify on the mask surface. The accumulation of paint over this surface can then be removed by immersing the mask in hot or boiling water,

whereby the wax converts from a solid to a liquid and floats off carrying the paint with it. Although such a system has been effective in eliminating the use of solvents, it also has some notable disadvantages. For example, it requires a specialized coating on the mask surface, thus adding an extra operation to the cleaning process. Further, the wax tends to create a fairly heavy film which may interfere with fine painting details in use, and thus the kind of mask on which such a wax system can be utilized is limited. More particularly, wax systems applied by spray have a tendency to emit wax particles into the atmosphere, resulting in the deposit of wax particles on production parts, which eventually must be rejected as paint will not adhere where the wax particles have been deposited.

Even later methods designed to cope with this problem entail the use of an aqueous gel as a coating for the mask prior to application of paint, the gel then being removable with steam or hot water. However, this method is also disadvantageous in three respects. First, the process controls required to form a gel of sufficient utility are too precise for efficient commercialization. Secondly, the use of steam or hot water to remove the gel creates not only an unnecessary step in the process but a waste disposal problem as well. Thirdly, application by spray causes the same problem as wax does, i.e. particles get into atmosphere and their deposit on parts in production causes rejects.

SUMMARY OF THE INVENTION

The present invention provides a method for removing a water-insoluble coating such as a paint or the like, from a substrate, such as a spray mask or other device, fixture, or structure. The method comprises applying an aqueous solution of certain film-forming materials to the substrate; drying the aqueous solution to form a barrier film, or coating, on the surface of the substrate; and then, after accumulating paint on the substrate, subjecting the painted substrate to the action of the same aqueous solution. It is a feature of the invention that as the foregoing steps are carried out cyclically, accumulated paint is, in each cycle, substantially completely removed from the substrate and concurrently the substrate is wetted with a solution which, upon subsequent drying, redeposits the barrier coating on the substrate to facilitate the removal of a subsequent accumulation of paint.

For a more complete understanding of the present invention, reference is made to the following detailed description and examples thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In accordance with the present invention, a method for removing a water-insoluble coating, such as a paint or the like, from the surface of a substrate, such as a spray mask or other substrate, generally comprises:

(a) depositing on the substrate a barrier coating of a water-soluble material;

(b) effecting the accumulation on said barrier coating of said water-insoluble coating;

(c) effecting the removal of said water-insoluble coating by subjecting the coated substrate to the action of an aqueous solution, which upon subsequent drying, redeposits said water-soluble barrier coating on said substrate, the temperature of the solution being in the range of about 110–212° F.; and

(d) drying said substrate to effect said redeposition.

The expression, "subjected to the action of" the aqueous solution is used herein to mean (a) that the coated substrate is immersed in the solution while the latter is agitated, (b) the solution is sprayed against the substrate, or the like in a manner which causes the solution to redis-

solve the barrier coating and mechanically strip off the paint coating.

It will be appreciated by those skilled in the art that the present process defines a distinct improvement in that it is possible by the invention to concurrently strip the water-insoluble coating from the substrate and rewet the substrate with a solution which, upon drying, redeposits the initial barrier film. Thus, in essence, a "one-shot" process for protecting substrates from water-insoluble coatings is provided herein. Further, the solution of the film-forming material can be readily filtered, decanted, or otherwise treated to remove the insoluble coating from the system. In this manner the aqueous solution can be reused almost indefinitely with very little waste.

The term "barrier coating" or "barrier film," as used herein, means a coating which is impervious to paint, resistant to penetration by paint, prevents effective contact of paint with a substrate, or the like in a manner such that the normally adherent paint does not adhere to the substrate at all, or weakly so.

The aqueous solution contemplated for use in the practice of the present invention can consist of a film forming material as the sole solute but it is preferred that an aqueous solution comprise a film forming material and a detergent.

The film-forming materials which are most advantageously employed in the practice of the present invention are, for the most part, water-soluble salts or certain water-soluble, naturally occurring materials. The most valuable of the salts are the alkali metal hypophosphates, hexametaphosphates, metaphosphates, orthophosphates, pyrophosphates, triphosphates, silicates, citrates, tartrates and lactates. The most valuable of the naturally occurring materials are casein, sucrose, glucose, gum arabic, gum tragacanth, vegetable proteins and the like, as well as mixtures thereof. The term "alkali metal" includes sodium, potassium, and ammonium.

In the practice of the present invention the preferred film-forming material is an alkali metal silicate; e.g. sodium silicate. Sodium silicate, as presently commercially available, does not have a fixed chemical formula and is defined in terms of SiO_2 content and Na_2O content. Although all commercially available forms thereof (e.g., metasilicate, orthosilicate, disilicate, water glass) will work in the practice of the present invention, it is preferred that the sodium silicate have a minimum SiO_2 to Na_2O ratio of about 2:1, and a ratio preferably within a range of from about 2:1 to 4:1.

The inclusion of detergents, or cleansers, although not essential to the successful practice of the present invention, renders the invention more valuable and practicable. These compounds have been found to assist in the invention in a number of ways. First, they reduce the surface tension of the water, thereby effecting a uniform deposition of the film-forming material. Second, they emulsify the paint, thereby avoiding the redeposition thereof. Further, some inorganic salt detergents act as water conditioners and some tend to improve the barrier film formed on the substrate.

Representative of useful inorganic detergents are, for example, the alkali metal hydroxides, carbonates, silicates, hypophosphates, hexametaphosphates, metaphosphates, orthophosphates, pyrophosphates, tripolyphosphates, and mixtures thereof.

Representative of the useful organic detergents are the anionic, cationic, and non-ionic detergents, for example; lauryl sulfate, sodium isopropyl sulfonate, dioctyl sodium sulfonate, diamyl sodium sulfonate, quaternary ammonium salts, ethoxylated polyoxypropylene glycol, ethoxylated alkyl phenols and the like. (See, for example, McCutcheon's: Detergents and Emulsifiers, 1971 Edition and the surfactants disclosed in U.S. Pat. Nos. 2,674,619 and 2,677,700 by way of example).

In the practice of the present invention, the preferred detergent is sodium orthophosphate.

The concentration of the film forming material can be any concentration which is effective in forming a barrier film, that is, it can be that of a saturated solution or any lesser concentration which provides an adequate thickness of film. Generally, however, I prefer to prepare and store a solution wherein the film forming material is at a concentration of about 1–50% by weight and use the solution either at that concentration or, in some cases, in more diluted form. Where the degree of solubility permits, I particularly prefer to prepare and store the solution with a concentration of film forming material at about 15–30% by weight and use the solution at that concentration or diluted up to as much as three times its volume with water (that is, a final preferred concentration of film forming material in the range of 3–30% by weight).

It will be apparent that the concentration of a saturated solution of a film forming material varies considerably from one material to another. Similarly the concentration of a saturated solution of any one such material may be considerably different at ambient temperatures as compared to 200° F. for example. Therefore, a mixture may be prepared at 75° F., for example, which comprises a saturated solution of a film forming salt and a proportion of the undissolved solid salt, the latter going into solution at or below the temperature at which the solution is used.

The detergents vary widely in their most effective concentrations but generally may be used, if at all, in a concentration up to about 25% by weight. However, any lowering of the surface tension is desirable and therefore relatively minor proportions of detergent can be used with advantage. Where the detergent is an inorganic salt, it is used preferably in the range of 15–25% by weight. Where the cleansing agent is an organic detergent, it is most often used in relatively lower percentages, that is, a fraction of one percent up to about 10% by weight. Matters such as excessive foaming on the one hand, and the attainment of a desired emulsification of paint particles on the other hand tend to dictate the proportion of a particular organic detergent. Where necessary defoamers may be used.

Some materials; for example, sodium silicate and sodium phosphate, are both film forming materials and detergents.

As indicated the ratio of film forming material to detergent can vary widely. It is preferred however, to use a ratio of film forming material to inorganic detergent in the range of 3:1 to 0.5:1 or even better in the range of 2:1 to 1:1.

In carrying out the method of the invention, the clean, unused substrate is first subjected to the action of the film forming solution preferably at a temperature ranging from 110° to 212° F., or, better, at a temperature ranging from about 170° to 205° F., by any suitable method such as spray application, immersion or the like. After the diluted aqueous solution has wetted the spray mask, the water is evaporated to thereby deposit a film thereon. Water evaporation can be accomplished by any suitable drying means; such as forced heat, maintaining the substrate at an elevated temperature sufficient to evaporate the water upon exposure to ambient or room temperatures, or simply with ambient temperatures air from a compressed air source directed from an air nozzle at the substrate.

After the film is formed, the spray mask is ready for use. When following use, sufficient amounts of paint have accumulated on the surface of the mask to necessitate the cleaning thereof, the mask is preferably immersed in a heated bath of the aqueous solution, maintained under agitation, and at a temperature ranging from about 110° to 212° F., preferably a temperature ranging from about 170° to 205° F., to remove substantially 100% of the paint and to concurrently reapply an aqueous solution of film-forming material to the spray mask.

In a preferred mode of practicing the invention, the spray mask is immersed in the diluted aqueous solution maintained at the hereinbefore defined temperature for a period of time sufficient to permit the paint mask to

reach a temperature approaching that of the aqueous solution, generally in a period of time ranging from about 15 seconds to 3 minutes, usually from about 1 to 1½ minutes. After the mask is removed from the heated solution, the solution is then allowed to dry thereon. This may be achieved solely through the emission of heat from the spray mask and is usually completed in about 20 seconds to 1 minute. The mask is then ready for reuse.

The time of immersion can be important also to the removal of paint in that paint is more easily removed if it has "dried"; that is, expelled solvent, polymerized, or the like depending on the type of paint used and its mechanism of "drying." Subjecting the paint layer to the action of the aqueous solution at a temperature of 170°–205° F., for at least one minute assists in such drying and the more complete removal of paint.

It will be apparent to those skilled in the art that if the diluted solution used for application of the film-forming material is maintained under agitation, then this same solution can be used for removal of the paint and reapplication of the solution. Thus, the present invention provides, in its preferred embodiment, and as it is carried out cyclically, for the removal of water-insoluble coatings from a substrate, with the concurrent application thereon of the aqueous solution which, upon subsequent drying, redeposits a protective coating of a water-soluble, film-forming material.

For a more complete understanding of the present invention, following are specific, non-limiting, examples thereof. In the examples, all parts are by weight, absent indications to the contrary.

Example I

Into a heated tank maintained at 195° F., equipped with agitation means, and containing a diluted aqueous solution of a film-forming material was immersed a spray mask for about 1 minute. The mask, which was then at a temperature of about 195° F., was removed from the tank and the aqueous solution was allowed to dry in an open atmosphere, leaving a uniform thin film thereon.

The mask was then sprayed with a commercially purchased enamel paint until it was substantially completely coated with the paint.

Thereafter, the spray mask was reimmersed in the heated tank, under agitation, for a period of about 3 minutes, during which time the paint was removed therefrom and a new aqueous solution of film-forming material was deposited thereon. The mask was then dried, repainted and reimmersed in the aqueous solution cyclically.

The aqueous film-forming solutions employed were as follows:

A

Ingredient:	Parts
Sodium silicate (SiO_2:Na_2O=2.87:1)	7.56
Sodium orthophosphate	4.9
Ethoxylated nonylphenol (65% ethylene oxide)	0.25
Water	87.29
	100.0

B

Ingredient:	Parts
Glucose	6.25
Sodium citrate	6.25
Water	87.5
	100.0

C

Ingredient:	Parts
Soya protein	4.4
Ethoxyplated polyoxypropylene glycol (80% ethylene oxide	6.25
Water	89.35
	100.0

D

Ingredient:	Parts
Sodium silicate (SiO_2:Na_2O=2.87:1)	7.5
Water	92.5
	100.0

E

Ingredient:	Parts
Gum arabic	6.25
Sodium carbonate	5.0
Ethoxylated polyoxypropylene glycol (80% ethylene oxide)	0.25
Water	88.5
	100.0

F

Ingredient:	Parts
Sodium lactate	5.25
Dioctyl sodium sulfosuccinate	5.5
Ethoxylated nonylphenol (65% ethylene oxide)	0.25
Water	89.0
	100.0

Composition E exhibited more foaming than was desirable and, therefore, 0.12% of a commercially available defoamer was added.

The following table shows the efficiency in paint removal exhibited by each of the above solutions by visual observation:

Film-forming solution	Film properties	Percent paint removal: First application	Percent paint removal: Second application
A	Dry	100	100
B	Tacky	90	90
C	Dry	80	75
D	Dry	85	85
E	Dry	95	90
F	Tacky	80	80

Example II

Following the procedure of Example I, a spray mask having a film deposited thereon was repeatedly sprayed with an alkyd resin paint and immersed in the heated tank to concurrently strip the paint therefrom and reapply the film-forming aqueous solution.

After repeating this procedure twenty times it was observed that in each instance a dry film was formed and 100% of the paint was removed from the spray mask.

The film-forming aqueous solution employed consisted of the following:

Ingredient:	Parts
Sodium silicate (SiO_2:Na_2=3.22:1)	9.17
Sodium orthophosphate	7.08
Ethoxylated nonylphenol (65% ethylene oxide)	0.24
Water	83.46
	99.95

A commercially available defoamer (0.05%) was used to reduce the foaming.

The foregoing examples were repeated using a wide variety of film-forming materials, a wide variety of detergents, a wide variety of percentages of chemicals, and various temperatures up to the boiling point of the aqueous solution. In this manner the various preferred chemicals and preferred operating conditions, as set forth above, were determined.

The term "water-insoluble coating" includes those formed from paints wherein water is used as a reducer, or diluent, with an organic solvent; those formed from paints wherein water is used as a vehicle for an emulsion,

or latex; and the like, as well as the more traditional water-free paints, lacquers, enamels, and the like.

I claim:

1. A method for removing a water insoluble coating from a substrate to which the coating is normally adherent which comprises:

(a) depositing on said substrate a barrier coating of a water soluble material;

(b) effecting the accumulation on said barrier coating of said water-insoluble coating;

(c) effecting the removal of said water-insoluble coating by subjecting said coated substrate to the action of an aqueous solution containing a water soluble barrier coating material which solution, upon subsequent drying, redeposits said water soluble barrier coating on said substrate, the temperature of said solution being in the range of about 170°–205° F. and the period of time of subjecting said substrate to said action being a time sufficient for the temperature of said substrate to approach that of said solution; and

(d) drying said substrate to effect said redeposition.

2. The method of claim 1 wherein the initial deposition of said barrier coating is made by subjecting the substrate to the action of said aqueous solution.

3. The method of claim 1 wherein said coated substrate is subjected to the action of said aqueous solution by immersing said coated substrate in an agitated bath of said solution.

4. The method of claim 1 wherein said barrier coating comprises a compound selected from the group of water soluble, film-forming materials consisting of casein; sucrose; glucose; gum arabic; gum tragacanth; vegetable protein; an alkali metal orthophosphate, hypophosphate, hexametaphosphate, metaphosphate, pyrophosphate, tripolyphosphate, silicate, citrate, tartrate, or lactate; and mixtures thereof.

5. The method of claim 4 wherein said barrier coating comprises sodium silicate.

6. The method of claim 1 wherein said aqueous solution comprises a compound selected from the group of water soluble, film-forming materials consisting of casein; sucrose; glucose; gum arabic; gum tragacanth; vegetable protein; an alkali metal orthophosphate, hypophosphate, hexametaphosphate, metaphosphate, pyrophosphate, tripolyphosphate, silicate, citrate, tartrate, or lactate; and mixtures thereof; said compound being at a concentration sufficient, upon said drying, to deposit said barrier coating on said substrate.

7. The method of claim 8 wherein said aqueous solution comprises between about one percent by weight and a saturated solution of said compound.

8. The method of claim 6 wherein said aqueous solution comprises about 3–30 percent by weight of said compound.

9. The method of claim 1 wherein said aqueous solution comprises a detergent in a concentration sufficient to effect the lowering of the surface tension of said solution.

10. The method of claim 9 wherein said detergent is selected from the group consisting of an organic anionic compound; an organic cationic compound; an organic non-ionic compound; an alkali metal orthophosphate, hypophosphate, hexametaphosphate, metaphosphate, pyrophosphate, tripolyphosphate, or silicate; and mixtures thereof.

11. The method of claim 9 wherein said material is an alkali metal silicate and said detergent is an alkali metal orthophosphate.

12. The method of claim 11 wherein said silicate is sodium silicate and said orthophosphate is sodium orthophosphate.

13. The method of claim 12 wherein said sodium silicate has a SiO_2:Na_2O ratio in the range of 2:1 to 4:1 and the proportion of said sodium silicate to said sodium orthophosphate is in the range of about 3:1 to 0.5:1.

14. The method of claim 9 wherein said detergent is an alkali metal salt detergent in a finite concentration up to about 25 percent.

15. The method of claim 1 wherein said aqueous solution comprises between about one percent by weight and a saturated solution of said water soluble material.

16. The method of claim 1 wherein said aqueous solution comprises about 3–30 percent by weight of said water soluble material.

17. The method of claim 1 wherein said aqueous solution comprises said water soluble material and an inorganic detergent in a ratio by weight in the range of 3:1 to 0.5:1.

18. The method of claim 17 wherein said ratio is in the range of 2:1 to 1:1.

19. The method of claim 1 wherein said aqueous solution comprises sodium silicate wherein the ratio SiO_2:Na_2O is in the range of 2:1 to 4:1.

20. In the method

(a) wherein a substrate is coated with a barrier coating to facilitate removal of a water insoluble paint coating to be coated thereon;

(b) wherein said barrier coating is then coated with said water-insoluble paint coating;

(c) wherein said coatings are subsequently removed; and

(d) wherein said steps are repeated cyclically:

the improvement which comprises carrying out the step of removing said coatings by subjecting said coated substrate to the action of an aqueous solution containing a water soluble barrier coating material which solution, upon subsequent drying, deposits a water soluble barrier coating on said substrate, the temperature of said solution being in the range of about 170°–205° F. and the period of time of subjecting said substrate to said action being a time sufficient for the temperature of said substrate to approach that of said solution.

21. The method of claim 20 wherein said coated substrate is subjected to the action of said aqueous solution by immersing said coating substrate in an agitated bath of said solution.

22. The method of claim 20 wherein said barrier coating comprises a compound selected from the group of water soluble, film-forming materials consisting of casein; sucrose; glucose, gum arabic, gum tragacanth; vegetable protein; an alkali metal orthophosphate, hypophosphate, hexametaphosphate, metaphosphate, pyrophosphate, tripolyphosphate, silicate, citrate, tartrate, or lactate; and mixtures thereof.

23. The method of claim 22 wherein said barrier coating is sodium silicate.

24. The method of claim 20 wherein said aqueous solution comprises a compound selected from the group of water soluble, film-forming materials consisting of casein; sucrose; glucose; gum arabic; gum tragacanth; vegetable protein; an alkali metal orthophosphate, hypophosphate, hexametaphosphate, metaphosphate, pyrophosphate, tripolyphosphate, silicate, citrate, tartrate, or lactate; and mixtures thereof; said compound being at a concentration sufficient, upon said drying, to deposit said barrier coating on said substrate.

25. The method of claim 24 wherein said aqueous solution comprises between about one percent by weight and a saturated solution of said compound.

26. The method of claim 24 wherein said aqueous solution comprises about 3–30 percent by weight of said compound.

27. The method of claim 20 wherein said aqueous solution comprises a detergent in a concentration sufficient to effect the lowering of the surface tension of said solution.

28. The method of claim 27 wherein said detergent is selected from the group consisting of an organic anionic compound; an organic cationic compound; an organic non-ionic compound; an alkali metal orthophosphate,

hypophosphate, hexametaphosphate, metaphosphate, pyrophosphate, tripolyphosphate, or silicate; and mixtures thereof.

29. The method of claim **27** wherein said material is an alkali metal silicate and said detergent is an alkali metal orthophosphate.

30. The method of claim **29** wherein said silicate is sodium silicate and said orthophosphate is sodium orthophosphate.

31. The method of claim **30** wherein said sodium silicate has a SiO_2:Na_2O ratio in the range of 2:1 to 4:1 and the proportion of said sodium silicate to said sodium orthophosphate is in the range of about 3:1 to 0.5:1.

32. The method of claim **27** wherein said detergent is an alkali metal salt detergent in a finite concentration up to about 25 percent.

33. The method of claim **20** wherein said aqueous solution comprises between about one percent by weight and a saturated solution of said water soluble material.

34. The method of claim **20** wherein said aqueous solution comprises about 3–30 percent by weight of said water soluble material.

35. The method of claim **20** wherein said aqueous solution comprises said water soluble material and an inorganic detergent in a ratio by weight in the range of 3:1 to 0.5:1.

36. The method of claim **35** wherein said ratio is in the range of 2:1 to 1:1.

37. The method of claim **20** wherein said aqueous solution comprises sodium silicate wherein the ratio SiO_2:Na_2O is in the range of 2:1 to 4:1.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,846,172 Dated 11-5-74

Inventor(s) Charles G. Fossati

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 7, line 49, delete "8" and insert --6--.

Signed and Sealed this

sixteenth Day of *September 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

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