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[54] **SURFACE GLOSS OF VINYL COATINGS**

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[58] **Field of Search** .... 117/64 R, 65.2, 11, 117/15, 76; 156/78, 209; 161/116, 119, 160

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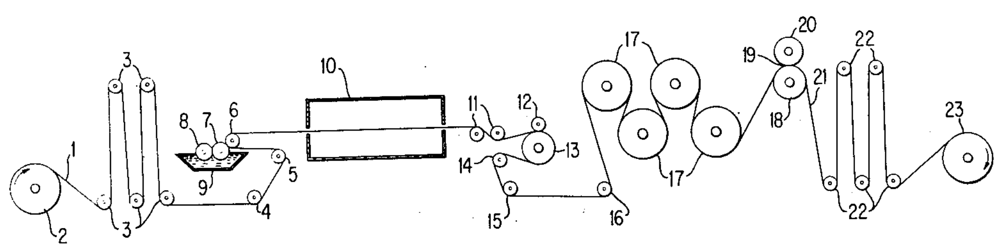
[57] **ABSTRACT**

The surface gloss and appearance of vinyl plastisol coatings adhered to substrates are improved by a process comprising passing the coated substrate in cooled condition in contact with a surfacing roll maintained at a temperature of about 320°–420°F and a contact pressure of about 2–100 pounds per linear inch.

13 Claims, 1 Drawing Figure



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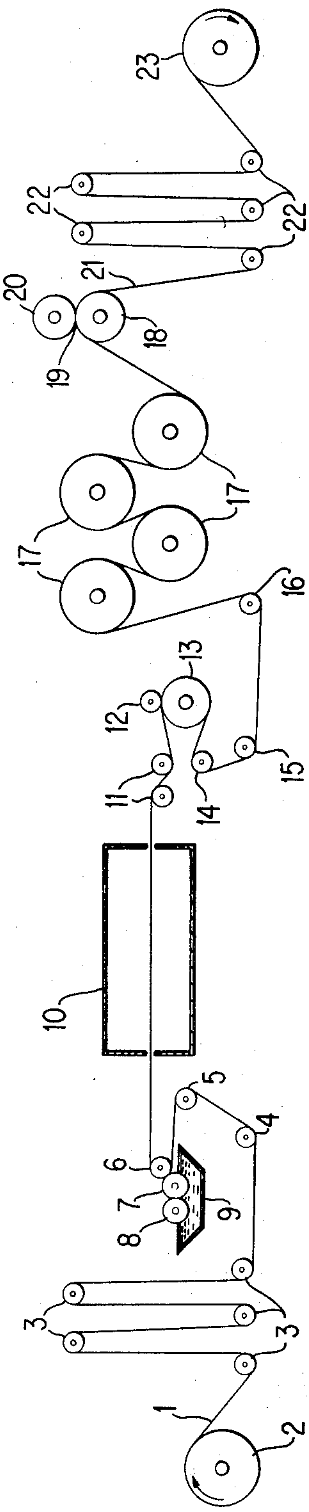

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SURFACE GLOSS OF VINYL COATINGS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a novel process for controlling the surface gloss and for improving the appearance and uniformity of thermoplastic coatings on substrates and, more particularly, for improving the gloss of vinyl coated floor coverings.

2. Description of the Prior Art

It is known in the prior art that transparent coatings of vinyl plastisols and related materials when applied to various substrates inherently possess a surface influenced by the size of the resin particles and other factors which can result in submicroscopic roughness resulting in a loss of gloss and clarity and uniformity thereof. Many attempts have been made in the art to improve these factors. In particular, in the field of vinyl floor coverings, many attempts have been made to improve the appearance of the final product.

It is, of course, well known that the technology of imparting a surface finish or embossing of thermoplastic sheets can be applied to vinyl floor coverings to improve their appearance. Most of the prior art in this area is concerned, however, with the application to solid products, that is, those which do not include a cellular layer. Moreover, while the use of planishing (e.g., polishing) equipment to enhance the gloss on vinyl substrates is not new, procedures for obtaining a difference in gloss plateaus and valley areas of a textured product have not been generally successful. In practice the prior has dealt with planishing of homogenous surface coverings which do not involve a textured substrate.

The styling of vinyl coated substrates or surfaces such as vinyl tile and the like, is the single most important aspect which influences sales. In fact, it is the factor which usually leads to selection for purchase by the customer. At the present time, very high gloss (the "wet look") is an important styling factor. One method of achieving a very high gloss is by application of wax or lacquer. The present invention provides a different method for obtaining the high gloss. Accordingly, it is clear that there is a need in the art for a simple and inexpensive method of improving or enhancing the gloss of vinyl coated substrates and particularly floor coverings using existing equipment. Moreover, there is a need to improve or enhance the gloss on textured substrates. The method of the present invention achieves these aims.

SUMMARY OF THE INVENTION

It is accordingly one object of the present invention to provide a method for increasing the gloss level of a vinyl coated substrate.

A still further object of the invention is to enhance or improve the surface gloss of a transparent coating of a vinyl plasticsol applied to a cellular substrate.

A still further object of the invention is to provide a method for enhancing the appearance and increasing the gloss of homogeneous or textured vinyl plastisol coatings adhered to cellular substrates by a method and apparatus easily incorporated into existing production equipment.

Other objects and advantages of the present invention will become apparent as the description thereof proceeds.

In satisfaction of the foregoing objects and advantages, there is provided by this invention a method for controlling the surface gloss and improving the appearance and uniformity of vinyl plastisol transparent wear coatings, particularly those contained on cellular substrates, which comprises passing the coated substrates in cooled condition in contact with a polishing roll maintained at a temperature of about 320°–420°F under a contact pressure of about 2–100 pounds per linear inch. Also provided are the products resulting from the gloss improvement process.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As pointed out above, the method of the invention is concerned with the control and enhancement of the surface gloss on vinyl coated substrates and, in particular, is concerned with improving the appearance and uniformity of clear vinyl coated homogeneous or textured substrates, such as vinyl floor coverings surfaced with a clear wear coating, such as vinyl plastisol.

According to this invention, it has been found that if a solid or cellular substrate containing a clear wear coating, such as a vinyl plastisol coating, is cooled to about room temperature and then passed in contact with a polishing roll wherein the substrate and coating are in cooled condition relative to the polishing roll, e.g., about 150°F or less, and the polishing roll is at a temperature of about 320°–420°F and under a pressure of 2–100 pounds per linear inch, the appearance of the vinyl plastisol wear coating is marked by a measurable improvement in surface smoothness and the presence of a mirror gloss. Moreover, it has been found that the brilliance of colors is improved as the haze resulting in light diffusion is removed in the same way a ferrotyped photographic print improves shadow detail and blacks. Moreover, the method of this invention permits the use of lower cost larger particle size resins in the coating by improving the gloss to a higher level therefore improving the economics of the commercial process.

The substrates and wear coatings to which the invention is applicable are not considered to be restricted to any particular classes. Generally however, the substrate preferably includes an asbestos or cellulosic sheet bound together by an elastomeric polymer, such as a styrene-butadiene copolymer by known methods. Usually in solid products one or more layers of a substrate are adhered to a top wear layer. When it is desired to have a cellular product, a cellular or foamed layer is adhered to the base asbestos or cellulose sheet. The foam layer may vary in color, thickness, and in the nature of any of its ingredients, although a vinyl composition, such as polyvinyl chloride, or a polyurethane, is preferred for this layer. This surface is then customarily printed with a multicolor design, as by rotogravure. The design variations are limitless. The wear surface layer may vary in thickness, for example from 0.005 to 0.025 inch and in the nature of its ingredients, although a thermoplastic composition is generally required, and a vinyl dispersion type of coating is preferred. A preferred wear layer is a vinyl chloride polymer (e.g., PVC) plasticizer paste without a volatile solvent. In general however, plastisols, in which a vinyl resin is dispersed in a plasticizer, are highly preferred top or wear layers. Some interrelation of this coating with the invention exists. For example, the invention permits the conversion of gloss from a flat finish, as is normally characteristic of a film containing relatively coarse polymer particles, to a much higher gloss.

The substrates, wear layers and foam layers employed in the preferred products of the invention are those described in U.S. Pat. No. 3,458,337, granged July 29, 1969, and assigned to the same assignee, the disclosure of which is incorporated herein by reference. This patent discloses various substrates containing wear-layers and foamed interlayers and methods for their preparation including the components to be used as well as methods and compositions for printing or decorating. Therefore such compositions and methods represent preferred embodiments of the invention.

As pointed out above, the method of the present invention is applicable to treatment of any type of vinyl coated product. However, it has found particular application to the treatment of vinyl flooring in roll form, and it will be more specifically described for that embodiment. However, it is to be understood that the invention is not limited thereto.

Although not limited to flooring, a typical, specific example is the improvement of gloss on embossed rotogravure printed foam cored sheet vinyl floorcoverings, as currently commercially produced. A typical prior art floorcovering can be made by the following steps:

A pigmented (e.g., white) foamable vinyl plastisol at a thickness of 0.020 inch is applied to a felted water laid asbestos sheet 0.035 inch thick, containing an elastomeric impregnant. The foamable composition contains dispersion grade and extender grade polyvinyl chloride resin, plasticizers, stabilizers, a blowing agent (e.g., azobisformamide), and titanium dioxide.

After the coating application, e.g., by a reverse roll coater, the sheet enters a tunnel convection oven maintained at about 285°F. at a speed to provide a residence time of 2 to 4 minutes. This heat will gel, but not fuse the vinyl composition thus affecting a solidification with sufficient cohesion and strength to permit further handling and printing and without appreciable decomposition of the blowing agent.

The sheet is then cooled, wound on a roll and transferred to a second production line where it is printed in one or more colors by a rotogravure printer to produce a design such as tiles, woodgrain, marbles, floral, or any other desired pattern. The inks used are solutions of vinyl-acetate vinyl chloride copolymers, suitably colored with insoluble pigments. Drying of each sucessive color is achieved by air streams, which may be heated, to remove solvents. If chemical embossing is desired, one or more of the inks may contain a material to inhibit the foam formation in its area by reaction with the blowing agent and/or catalyst.

After winding up again, the sheet is transferred to the coating oven where a clear vinyl plastisol is applied by a reverse roll coater, at a thickness of about 0.010 inch. The sheet then enters the convection heated tunnel oven, maintained at a temperature of about 350°–400°F., for a residence time of 3 to 4 minutes. During this time the liquid plastisol gels, then fuses and the blowing agent decomposes, these effects taking place not as definite successive stages, but in effect overlapping. The result is a final product with a tough, transparent wear layer, a resilient and cushion-like intermediate layer on a strong and dimensionally stable supporting layer.

As an alternative to the chemical embossing (embossing by inhibiting ink compositions), the product may be embossed by suitable equipment as the hot product emerges from the oven. In either case, the sheet must then be cooled to approximately room temperature as by a series of large diameter water cooled steel drums, before it is wound on a roll for inspection and wrapping.

In the formation of the products of the invention, a representative composition of the foamable coating may be as follows:

For each 100 parts of a relative low molecular weight homopolymer dispersion PVC resin of 2.05 relative viscosity:

2,2,4-trimethyl pentanediol isobutyrate benzoate — 54.7
Epoxidized soya oil — 6.3
Zinc catalyst — 2.5
High boiling mineral spirits — 6.3
Titanium dioxide — 25.0
Azodicarbonamide — 2.5

The amount of foamable composition applied should be sufficient to provide a layer of about 0.005 inch thickness up to about 0.05 inch before expanding.

The coated web may be printed in a red brick pattern, the mortar joints being colored gray, the motar joint printing composition being the only printing containing the suppressant for the catalyst in the foamable composition, e.g., benzotriazole. The printing composition to be used may be that given as Example E in USP 3,458,337, mentioned above. However, in this illustration the coloring was varied to provide the desired gray color in the mortar joints.

A transparent top coating is to be applied over the printing by means of a reverse roll coater, which coating may be about 0.005 to 0.050 inch in thickness. The top coating composition may be as follows:

For each 100 parts of a high molecular weight homopolymer dispersion PVC resin of 2.65 relative viscosity:

2,2,4-trimethyl pentanediol isobutyrate benzoate — 42.00
Light stabilizer — 5.00
Epoxidized soya oil — 6.00
High boiling mineral spirits — 6.3
Alkyl phenyl ether of polyethylene glycol — 0.6

The product is cured in a hot air oven maintained at an air temperature of about 350° to 400°F., the residence time in the oven being about 5 minutes.

The brick areas of the printed pattern will expand or foam to a significant extent providing a noticeable relief in contrast with the lower mortar joints.

Obviously analogous compositions and methods may also be used, particularly those described in USP 3,458,337.

The above processes are representative of the product as it has previously been made. This invention entails the following additions to the above processes:

At a point between the cooling drums in the last step and the windup, a nip consisting of two rolls is provided. The sheet passes through this nip with the back in contact with a roll of intermediate hardness, e.g., a rubber roll, with an arc of contact of, for example 10° to 180°preferably about 70° to 120°. A second roll is arranged to engage with the sheet (with a line contact only) somewhere within the subtended angle of the arc of contact of the first roll, i.e., where the sheet is in good contact with the roll of intermediate hardness. This second roll is maintained at a temperature of between about 320°–420°F. The contact pressure may vary from a light to a heavy pressure of about 2 to 100 pounds per linear inch; or it may be operated at a fixed gap from the rubber covered roll. Its surface smoothness will determine the nature of the desired results which normally will be the highest gloss possible, therefore requiring a mirror finish on the roll. Best results can be obtained through the use of a chromium plated roll as this permits an excellent finish, corrosion resistance, and good release from the vinyl sheet. Although this high gloss is currently of most interest, other finishes, such as sheen or matte finishes are not excluded, and can be achieved by appropriately changing thhe finish of the chromium plated roll, herein called thee polishing roll.

Variations on this procedure involve the speed of sheet, the temperature of the roll, pressure in the nip and the contact of the nip. However, it should be understood that there must be no relative movement between the polishing roll, and the surface of the moving sheet during contact therebetween. The temperature may be partially dependent upon composition of the wear surface. For preferred compositions, beneficial results have been obtained at a roll temperature of from 320°–420°F., with optimum results in the 380° to 400°F. areas. It is believed that sheet speed, composition, width of contact of the nip (as determined by roll diameter) and temperature of the roll are all interrelated. A highly preferred sheet speed or contact time is about 50 to 150 feet per minute although this may be varied depending on the effect desired and other conditions.

As pointed out above, the prior art has been concerned principally, if not entirely, with solid products, that is, those not consisting of, nor incorporating a cellular layer. It is therefore, an unexpected result that it is possible to achieve the desired result of this invention without distortion, collapse, or destruction of the foam or cellular layer. In fact, it is believed that the resilient characteristics of the foam layer actually assist the process. Surface formation by application of a textured roll, such as embossing, is usually dependent upon a sheet temperature well above room temperature. It is believed novel in this process that a room temperature sheet is not only satisfactory, but in fact beneficial. The fact that there is no residual heat in the interior of the sheet minimizes or eliminates possible damage to the desired finish or cell structure which might otherwise occur.

It is also unexpected that the very brief contact would achieve the desired result. This is advantageous in reducing the recooling necessary, and in permitting complete disengagement of contact in the event of line stoppage. In addition, novelty resides in the high temperature of the surfacing roll and a correspondingly cool sheet temperature, as compared to some finishing operations using moderate sheet and approximately equal roll temperatures. Also, the ability to achieve gloss differences between elevated and depressed areas is a distinct new factor in foam products of the type contemplated.

The achievement of the improved gloss by this method, as compared to the use of an additional coating does not alter the homogenity of the wear surface and therefore does not impair surface characteristics, such as stain resistance, washability and coefficient of friction.

Reference is now made to the drawing accompanying the application which illustrates a specific embodiment of the invention for enhancing the surface gloss of a cellular substrate carrying a vinyl plastisol coating. In the drawing a latex bound asbestos base **1** coated with a foamable (preferably printed) layer of polyvinyl chloride resin containing plasticizers, stabilizers, titanium dioxide and a blowing agent (azobisformamide), as described in the prior art above, is unwound from roll **2**, passed through accumulator roll **3**, idler rolls **4** and **5** and then passed through a reverse roll coater comprising rolls **6**, **7** and **8** whereby a clear polyvinyl chloride plastisol is applied from pan **9**. The resulting coated substrate is then passed through convection oven **10** maintained at a temperature of about 375°F. for about 4 minutes residence time, during which fusion and blowing take place. On emerging from the oven, the coated cellular substrate is passed around air guides **11** and through idler rolls **13, 14, 15** and **16.** In an alternative embodiment, after emerging from the convection oven **10**, the coated substrate may be deep-embossed by patterned-embossing roll **12** as it passes roll **13** if an appearance of this type is desired. Thereafter the resulting coated cellular substrate is passed around cooling drums **17** under which conditions the temperature of the coated substrate is reduced to below about 150°F. and preferably about room temperature. At this point the back of the cooled coated substrate is passed in contact with a roll of intermediate hardness such as rubber roll **18** through an arc of about 150° in which arc a nip **19** is formed with polishing roll **20.** The polishing or planishing roll **20** is arranged to engage with the sheet at a line of contact within the subtended angle of the arc of contact of the roll **18**, i.e., where the sheet is in good contact with roll **18.** The intermediate hardness roll **18**, e.g., rubber roll, and coated substrate are at room temperature and the polishing roll is a chromium plated roll maintained at a temperature of about 390°F. The glossy coated substrate **21** is then passed around accumulator rolls **22** and wound on windup roll **23** for storage and shipment. The gloss of the wear coating was observed as being very high.

The invention has been described herein with reference to certain preferred embodiments. However, it is not to be considered as limited thereto as obvious variations thereon will become apparent to those skilled in the art.

What is claimed is:

1. A method for improving the surface gloss of vinyl coatings on substrates that comprises passing said vinyl coated substrate cooled to a temperature not exceeding about 150°F in contact with a polishing roll maintained at a temperature of from about 320°F to about 420°F, said polishing roll being maintained at a contact pressure of from about 2 to about 100 lbs. per linear inch, whereby the surface gloss of the vinyl coating is enhanced, thereby improving the appearance of the vinyl coated product.

2. A method according to claim **1** wherein contact with said polishing roll is carried out by passing the back of the coated substrate in contact with a roll of intermediate hardness through an arch of contact with a roll of intermediate hardness through an arc of contact of about 10°–180° and said polishing roll is arranged to engage with the coated substrate along a line of contact within the subtended angle of the arc of contact of the roll of intermediate hardness.

3. A method according to claim 2 wherein the substrate is a cellulose or asbestos base having a cellular or foam layer thereon and said wear layer is a transparent vinyl plastisol layer.

4. A method according to claim 3 wherein said roll of intermediate hardness is a rubber roll and said polishing roll is a chromium plated roll.

5. A method according to claim 4 wherein said coated substrate is maintained at room temperature and said polishing roll is maintained at a temperature of about 380° to 400°F.

6. A method for the production of a high gloss vinyl coating on a substrate comprising:

a. coating a substrate with a vinyl coating;

b. heating said coated substrate to a temperature sufficient to fuse said coating;

c. cooling the substrate having the thus-fused coating thereon to a temperature not exceeding about 150°F; and

d. passing said cooled, coated substrate in contact with a polishing roll maintained at a temperature of from about 320°F to about 420°F, said polishing roll being maintained at a contact pressure of from about 2 to about 100 lbs. per linear inch,

whereby a high gloss vinyl coating of enhanced appearance is obtained on the treated substrate.

7. A method according to claim 6 wherein contact with said polishing roll is carried out by passing the back of the coated substrate maintained at about room temperature in contact with a roll of intermediate hardness through an arc of contact of about 10° to 180° and said polishing roll is arranged to engage with the coated substrate along a line of contact within the subtended angle of the arc of contact of the roll of intermediate hardness.

8. A method according to claim 7 wherein the substrate is a cellulose or asbestos base having a cellular or foam layer thereon and said wear layer is a transparent vinyl plastisol layer.

9. A method according to claim 8 wherein said first roll of intermediate hardness is a rubber roll and said polishing roll is a chromium plated roll.

10. A method according to claim 9 wherein said coated substrate is maintained at room temperature and said polishing roll is maintained at a temperature of about 380° to 400°F.

11. A method according to claim 8 wherein the vinyl plastisol coated substrate is fused at a temperature of about 350°–400°F. for 3 to 4 minutes.

12. A method according to claim 11 wherein the vinyl plastisol layer has a thickness of about 0.005–0.025 inch and the cellular layer is a polyvinyl chloride layer.

13. A method according to claim 12 wherein the coated sheet is embossed by contact with an embossing roll after fusing and prior to contact with the polishing roll.

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