March 18, 1969 W. H. NUTTALL 3,433,694

PACKAGING METHOD

Filed Oct. 13, 1965

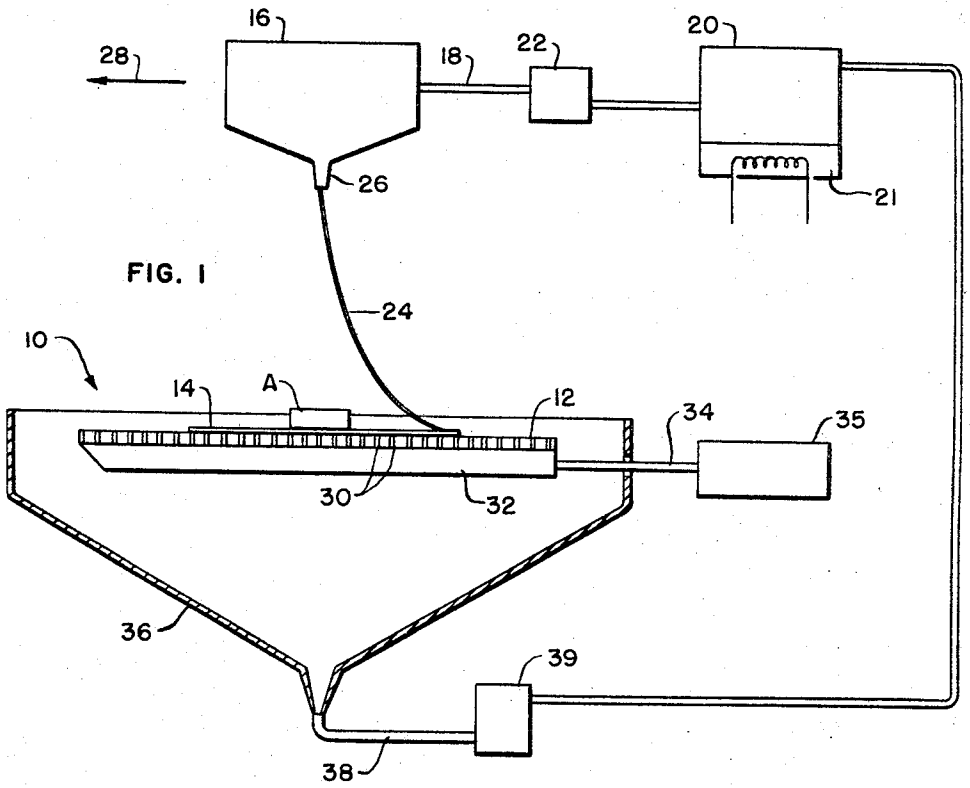


FIG. 1

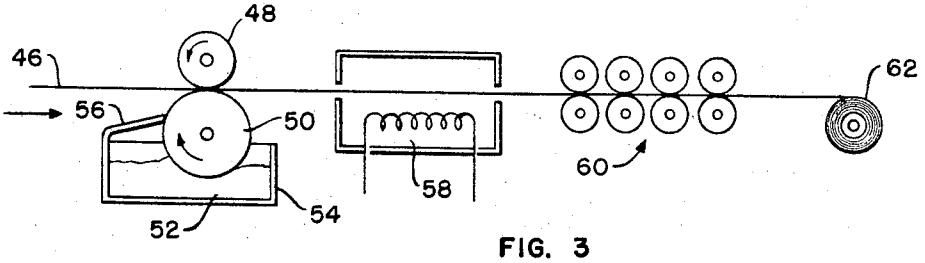


FIG. 3

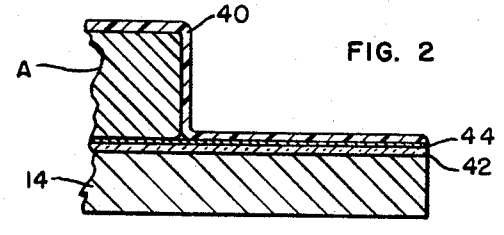


FIG. 2

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PACKAGING METHOD

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ABSTRACT OF THE DISCLOSURE

A skin packaging process in which a molten resin film is drawn into conformity with the packaged object by evacuating air through the paper backer, adhesion of the molten film to the backer being promoted by first coating the backer with finely divided pigmentary material containing an amount of resin particles to which the film adheres but which amount is insufficient to inhibit evacuation of air through the paper backer.

This invention relates to methods and materials used in packaging articles by so-called "skin packaging" technique.

In one such method, the articles to be packaged are positioned on backers comprising pieces of relatively rigid or at least shape retaining material such as paperboard which has been cut to size and is usually left flat. Over the assembly is positioned a film or cover sheet of synthetic resin, usually transparent, and while in a molten or formable state is drawn into close conformity with the backer surface and the article supported thereon by evacuating most of the air from between the film and backer.

In the form of "skin packaging" with which my invention is concerned, the cover film is formed in situ on the exposed surfaces of the assembly comprising the backer and the article positioned thereon by extruding molten resin through a nozzle to form a curtain or film which is deposited onto the assembly. Either the nozzle or the support for the backer is so moved that the deposited film covers the full area of the assembly. Simultaneously as the deposited film cools and sets, it is drawn into intimate contact with the exposed surfaces of the assembly by evacuating air through the material of the backer. The transparent film can therefore be caused to very closely contact the assembly and provide a very tight skin effect.

Any of the commonly available papers and paperboards as they come from the papermaking machine have sufficient porosity for this purpose, unless they have been specially treated in order to destroy their porosity. Moreover such papers and paperboards may be made conveniently available in a variety of different thicknesses and textures, so as to provide all the physical properties required of the backer to hold, protect and display the packaged article. The molten resin of which the cover film is formed in situ on the backer, however, does not satisfactorily adhere to the surface of such papers or paperboard.

Accordingly, it is a principal object of my invention to treat the surface of paper or paperboard stock, advantageously as it comes from the papermaking machine, in such a way as to promote its adhesion to the resin comprising the cover film, but without detrimentally affecting its porosity of air, which is essential to the practice of "skin packaging" where the "skin" is formed in situ as described above.

Previous to my invention, paperboard had been prepared for the "skin packaging" process by covering the surface of the backer with a suitable heat softenable lacquer or adhesive to which the cover film would adhere and then perforating the coated board to allow a suction device applied to the back of the paperboard to draw the heated film against the assembly by evacuating air through the perforations. Where the paperboard was to be printed with legends and/or colored for decorative purposes, this had to be done before the coating of heat softenable lacquer was applied.

To avoid the necessity of perforating the coated stock it also has been proposed to apply the lacquer or adhesive in spaced lines so as to leave uncoated areas permitting evacaution of air through the pores of the paperboard. Usually these lines of adhesives were applied to the backer surface after the article had been positioned thereon, and, in any event, were restricted to the surface area of the paperboard backer not receiving the article. It also has been proposed to partially oxidize the side of the film to be presented to the board and/or to coat the surface of the film with a small amount of adhesive. For example, if the film comprised polyethylene, it has been proposed to coat the surface thereof with polyalkyleneimine. In all of these instances, however, it has been necessary to work with already formed films and/or to cover the printer surface of the paperboard with an overlay of lacquer or adhesive.

It has now been discovered, and it is a feature of the present invention, that latices of emulsified resin particles, if sufficiently diluted, can be applied directly to the paperboard surface as it comes from the papermaking machine and then calendered or otherwise reduced to a required thinness to provide uniform layers having sufficient porosity and/or discontinuity as to facilitate the evacuation of air through the pores of the paperboard in the aforedescribed evacuating step of "skin packaging." Dependent on the composition of the resin patricles, then coatings will also supply the required adhesion or bond between the paperboard surface and transparent skin, particularly when the same is applied as molten resin and allowed to set in situ on the coated paperboard surface.

Where the paperboard is to be printed on the surface to which the cover film is to be bonded, dilution of the emulsified resin particles can conveniently be obtained by dispersing the resin particles in the clay or pigment dispersions which are ordinarily applied to the paperboard surface in order to prepare the same for the printing ink. Thus I have found that by controlling the amount of resin added to the aqueous dispersion of finely divided clay or pigment particles and the thickness of the coating thereof deposited on the paperboard surface, a sufficient amount of resin particles will be available to provide the desired adhesion to the molten resin which is deposited and allowed to set in situ thereon. Furthermore the emulsified resin particles will be sufficiently dispersed among the clay particles as to maintain a porosity of the clay

coating comparable to that of the paperboard. In this form of the invention, the ink is also printed on the coating so as to constitute a discontinuous pattern of closely spaced dots, and so that the molten resin can establish contact with the resin particles dispersed through the clay coating. I have found that satisfactory adhesion can be achieved between the molten resin film and the resin particle content of the clay coating where the ink dots comprise up to 80–90% coverage of the printed areas.

An advantage of this form of the invention is that not only is the desired adhesion of the molten resin film to the paperboard surface obtained, and without sacrificing the capacity of the paperboard to have a vacuum drawn therethrough, but since the ink layer does not have to be subsequently coated the inking step can be done at any time up to the time of actually "skin packaging."

Where the molten resin deposited on the paperboard backer to form the skin in my packaging technique comprises a resin of the class represented by cellulose esters such as cellulose acetate, cellulose acetate-butyrate or cellulose acetate-propionate, I find that the most satisfactory adhesion is obtained where the resin particles with which I coat the paperboard surface comprise one of a mixture of the conventionally available acrylic resins. These resins are particularly useful because of their capacity to wet the cellulosic resin molecules. On the other hand, where the molten resin constituting the cover film comprises a polyolefin such as polyethylene, polypropylene, or ethylene-propylene copolymer, the emulsified resin particles with which I coat the paperboard surface will be selected for their affinity with this class of film constituting materials. Examples of suitable resin particles which may be applied to the paperboard surface to bond polyolefin films thereto will include polyvinyl acetate and polyethylene imines. Dispersions of polyethylene particles and polyethylene oxide emulsified particles are further examples.

In the form of my invention where the emulsified resin particles are added to an aqueous dispersion of finely divided pigment particles used in preparing a paperboard surface for inking, I find the best results are obtained when the emulsified resin particles comprise between about 18 to 40% by weight of the pigment particles, considered on a solids basis, the coating of pigment and emulsified resin particles is applied at the rate of approximately 2 to 4 lbs. per 1000 square feet of paperboard surface. A preferred composition would comprise 25 parts of emulsified resin particles for 100 parts of pigment (clay or carbonate) particles.

When the emulsified resin particles are to be applied directly to the paperboard surface rather than in a mixture with the clay or pigment particles, I find that the amounts of emulsified resin particles actually applied to the paperboard surface can be much smaller. Thus, I find that it is sufficient if an aqueous dispersion of the emulsified resin particles is applied to the paper surface at a rate so as to deposit about .25 to 4 lbs. of emulsified resin particles per 1000 sq. ft. of paperboard surface.

I find that, when either of said application methods is employed, it is a feature of my invention, that I am able to obtain an adhesive bond between the paperboard and the cover film which is as strong as, or stronger than, the bonding forces which exist between the fibers of the paperboard itself. Moreover this bond is obtained without lessening the ability of the paperboard to have a "vacuum" pulled therethrough.

Thus, it is a feature of the present invention that coated paperboard is provided having a porosity sufficient to facilitate evacuation of air therethrough in "skin packaging," said coated paperboard having a surface which is readily wet by the molten resin comprising the cover film and to which coated surface the cover film readily and strongly adheres as its sets thereon.

A further feature of the invention is that the paperboard can be treated "in line" with the manufacture of the paperboard itself and requires no separate operations or special equipment other than that commonly found in a paper mill.

Another feature of the invention is that the treatment of the paperboard surface also prepares the surface for printing with ink whereby the costly operations of having to overcoat the ink and/or to perforate the paperboard after printing are avoided.

Many other objects, advantages and/or features of the invention will be at once apparent, or will become so upon consideration of the more complete description of the invention which now follows.

In the accompanying drawings:

FIGURE 1 illustrates in schematic form a preferred apparatus employed in "skin packaging" as contemplated by the practice of the present invention;

FIGURE 2 is a fragmented view taken through the "skin packaged" article and illustrates one embodiment of the invention; and

FIGURE 3 illustrates in schematic form one system of preparing the paperboard backer for the subsequent packaging operation.

Turning therefore now more particularly to the several views and first to FIGURE 1, there is indicated at A an article of hardware or other item to be packaged. For example, Item A may be considered to represent a hinge plate, a faucet or any other item that is desired to be "skin packaged." The apparatus which is used for packaging said article is indicated generally at **10** and comprises supporting structure, including a table **12** on which is placed the backer **14** which is to comprise one side of the skin package to contain the Item A. Backer **14** comprises a piece of air pervious paperboard which has been cut to desired size and shape and has its upper surface treated as herebefore mentioned and hereinafter more particularly described. Preferably, Item A is centered on the backer.

Apparatus **10** also includes a coating head indicated at **16** which is connected by conduit **18** to a heated reservoir **20**, which is kept filled with a supply of molten plastic resin, heated at **21**. Examples thereof includes cellulose esters such as cellulose acetate, cellulose acetate-butyrate and cellulose-propionate. The molten plastic resin may also comprise a polyolefin such as polyoethylene, polypropylene or ethylene-propylene copolymer. At **22** in line **18** is a pump by which flow of the molten resin is enforced from reservoir **20** through conduit **18** into the coating head and out through nozzle die **26** to form the extruded sheet or curtain **24** of molten resin which is deposited across the backer **14** and Item A centered thereon. Conveniently, nozzle **26** is adapted to extrude a sheet or curtain **24** having a width approximating one of the two dimensions of the paperboard backer **14**. Head **16** is also supported for reciprocal movement in the direction indicated by arrow **28** so that the extruded film or molten resin can be deposited across the full area of the paperboard backer **14**. The direction of reciprocal movement of the floating head will therefore be at right angles to the width of the extruded film **24**. In this arrangement table **12** and/or its support will be held stationary. However, it is also possible to hold the coating head **16** stationary and move the table and/or its supporting structure relative to the coating head to obtain the same result.

The upper surface of table **12** on which I place the paperboard **14** contains a plurality of regularly spaced perforations **30** communicating via a vacuum chamber **32** and conduit **34** to an evacuating pump **35**. Simultaneously, therefor, as the extruded film **24** of molten resin is deposited on the upper surface of the paperboard backer **14** and over the article A, air is simultaneously evacuated from between the deposited molten resin film **24** and the upper surface of the paperboard **14** through the pores of the paperboard itself. The vacuum which is thus created pulls or draws the hot film while it is setting into close conformity with the assembly constituting the paperboard

14 and article A so that it effectively sets and forms a skin tight contact therewith. At 36 is a tank in which is collected excess molten resin not drawn into conformity with the assembly and which drains off the table 12. This resin is returned via line 38 and pump 39 back to tank 20 for recycling.

It will be understood that through suitable modification of the illustrated apparatus, I am also able to run the packaging operation as a continuous process. For example, instead of placing cut to size pieces of paperboard on table 12, I can lead one end of a rolled web of coated paper stock onto the table surface 12 and continuously drive the paper web. Therefore in the interval after depositing a width of molten resin 24 across the web or backer 14 and after the coating head has returned to its "start" position, the vacuum can be automatically relieved to permit the web coated paper stock to be advanced to center the next portion thereof for continuance of the molten resin film application step and the serving of each completed package from the web. Many other possible variations and/or rearrangements of the described parts of the illustrated apparatus will be at once apparent, or will become so in the practice of the described method and are therefore intended to be included within the broad concept of the packaging operation thus far described.

The completed package on removal from table 12 is shown in FIGURE 2 as comprising the described paperboard backer 14 and an outer transparent film 40 of transparent cellulosic or polyolefin resin which upon setting of the molten film 24 is set into close conformity with article A. At 42 is a coating of emulsified resin particles dilutely dispersed through a considerably larger proportion of the finely divided clay or pigment particles previously applied to the paperboard by which a tight bond between the paperboard backer 14 and film 40 is promoted. 44 represents a discontinuous layer of ink preferably comprising a plurality of closely spaced but discrete individual dots of ink which are applied over coating 42. These dots of ink comprise up to 80% coverage of the printed area of the coating 42. The bond of the film 40 to the paperboaord substrate 14 is obtained through a weld which may be described as a quasi-chemical or physical intermingling of the emulsified resin particles content of the clay coating 42 and the film 40 which obtains through the interstices or spaces between the dots comprising the ink layer or film 44.

In accordance with the invention, the paperboard substrate 14 is not perforated but is air pervious. By this is meant that it has the initial porosity provided from the fourdrinier or other papermaking apparatus in which it is manufactured; assuming it has not been treated so as to destroy its porous character through which air may be withdrawn, as when connected to an air evacuating pump or the like. Furthermore, the particle size of the clay and emulsified resin particles dispersed therethrough and the thickness of the coating are such that coated paperboard prior to the application of the ink layer has a Gurley porosity of less than 3000 sec./100 cc.

Suitable apparatus for treating paper as it exits from the last dryer cylinder or calender rolls of a fourdrinier or other papermaking machine is illustrated by FIGURE 3. In this figure, web 46 of paperboard is considered as moving from the left to the right as it exits from the calender rolls of the papermaking machine.

In said FIGURE 3 the coating apparatus is illustrated as including a pair of oppositely turning rollers 48 and 50 through which web 46 of paperboard first passes on its exit from the papermaking machine. Roller 50 turns through a pool 52 of coating material contained within a pan 54 and serves to apply a coating therefrom to the underside of the web 46 across the full width thereof. At 56 is a doctor blade or other equivalent means for regulating the thickness of the coating layer applied. In one form of the invention, pool 52 comprises an aqueous suspension of finely divided pigment or clay particles in which are considerably diluted emulsified resin particles, the composition of which is dependent upon the desired composition of the molten resin curtain 24 applied in the "skin packaging" operation illustrated by FIGURE 1 and discussed above to produce the outer transparent skin 40.

There follows a typical composition which may be used where the molten resin which forms cover film 40 is of a cellulosic nature, as for example comprising cellulose acetate, cellulose butyrate or cellulose acetate-propionate. Such a composition would comprise the following ingredients and in the indicated proportions by weight.

TABLE A

	Range	Preferred composition
Finely divided pigment or clay particles	100	100
Emulsified acrylic resin particles	18–40	20
Sodium hexametaphosphate	.08	.08
Water	8.0	8.0
Sodium polyacrylate (Acrysol ASE 95)	0.4	0.4
Ammonium hydroxide	0.4	0.4

The finely divided pigment or clay may be any of the finely divided mineral matter, such as are conventionally applied to level and/or otherwise prepared paperboard surface for ink printing. Preferably it will consist primarily of clay, such as kaolin, although it may include such other materials as blanc fixe, finely divided metal such as aluminum, color lakes, tinctorial oxides, or the like, and have an average particle size of less than 2 microns. In a typical clay, 90% of the particles will be less than 2 microns and the remainder less than 5 microns in diameter. I omit binders, such as casein, glue, starch or the like, which have been used conventionally by the art for bonding the finely divided pigment particles to the paperboard surface. Instead, I rely upon the emulsified resin particle content which I mix therewith to obtain the clay particle bond.

The emulsified arcylic resin particles may comprise any of the conventionally available acrylic resins, and will have a particle size of less than 0.1 micron. For example, the resin particles may comprise polymerized methyl acrylate, ethyl acrylate or butyl acrylate. Mixtures of these may also be used. Additionally, these acrylates may be copolymerized with acrylonitrile or ethyl, methyl or butyl methacrylate. Preferably, however, I use the proprietary acrylic resin identified by the trademark Rhoplex B–15 which is available commercially as an aqueous dispersion containing 46% acrylic resin solids of a particle size less than 0.1 micron and described by its manufacturer as an emulsion of the non-ionic type having a pH of 6.0–6.8. The acrylic resin solids of Rhoplex B–15 are understood to comprise a water soluble interpolymer of the type disclosed by U.S. Patent 2,795,564 which are formed from (A) units having carboxylate groups derived from a polymerizable carboxylic acid having alpha, beta unsaturation in a vinylidene group together with (B) units from at least one neutral, free-radical polymerizable ester having a vinylidene group attached to the functional groups which ester by itself forms soft polymers and (C) units from at least one neutral polymerizable monovinylidene compound which by itself forms a hard polymer such as alkyl methacrylate in which the carboxylate units constitute from .05 to 2.5% of the interpolymer and the ration of (B) units to (C) units is between 9:1 and 1:20. Clear films of Rhoplex B–15 are known to have a molecular weight greater than 2×10^6 power, an index of refraction of 1.48 and a specific gravity of 1.09. Usefully the composition may also contain a small amount of a defoamer such as tributyl phosphate. Various proteins and/or starches, as are conventionally added to clay coatings in preparing paperboard for printing, are avoided as detrimental to the porosity and adhesion thereof.

When the molten resin used to form cover film **40** comprises a polyolefin, at least some proportion of the acrylic resin particles will be replaced by particles of resin having a greater affinity for the polyolefin content of said cover films **40**. Thus it is believed that the adhesion between the cover film **40** and the paperboard backer **14** derives from the ability of the acrylic resin particles in the coating **42** to wet the cellulosic molecules of the paperboard backer **14** and of the cellulose ester comprising the cover film **40**. The acrylic resins, however, have less affinity and/or ability to wet the polyolefin molecule. Accordingly, I find it advantageous to add a small amount of polyethylene imine or polyethylene oxide. A dispersion of polyethylene particles may also be added to the composition. Thus, a typical composistion comprising pool **52** with which to coat the paperboard web **46** where the "skin packaging" utilized molten polyolefin resin would be as follows:

TABLE B

	Range proportions	Specific example
Finely divided pigment or clay particles	100	100
Emulsified acrylic resin particles	18–25	18
Polyethylene imine	5–10	5
Sodium hexametaphosphate	.08	.08
Water	8–10	10

The coated paper web **46** after being coated is directed through an oven or other heated area **58** to remove the water content and from whence it is passed between a plurality of calender rolls indicated generally at **60**. The calender rolls serve to smooth out the coated surface so as to render it level or otherwise conducive for the ink film to be subsequently printed thereon. The calender rolls also serve to thin the coating to the desired weight range of 2 to 4 lbs. per thousand square feet of paperboard surface area. It has been found important to maintain the clay-emulsified resin particle coating within this range of thickness, since thinner coatings invite adhesion problems because of the insufficient amount of resin available to wet or otherwise obtain adherence to the molecule of molten resin as it sets to form the cover film **40**. On the other hand, amounts in excess of said weight range build up such thicknesses as to impair the porosity of the coated paper. On exiting from the calender rolls **60**, the paper web **46** is coiled at **62** until needed for packaging or for delivery to the printing apparatus. Paper treated in accordance with the present invention may be printed by any of the conventioinal printing apparatus. Gravure roll, offset or letterpress printing systems are examples thereof that may be utilized. It is, however, important that a printing technique be employed such as to apply a discontinuous ink pattern comprising closely spaced discrete dots of ink, as opposed to a continuous film of ink. Most satisfactory results are obtained when density of the dots is so controlled that their coverage does not exceed 80–90% of the total printed area. If a greater coverage is required, then I prefer to add up to 6% by weight of one of the mentioned acrylic resins to the ink. It will be understood, of course, that in the selection of inks, those containing waxes, greases, and polyethylene emulsions will be avoided, otherwise almost any ink typical of the described printing processes may be utilized, off-set sprays are also to be avoided. For example, typical inks will be those employing drying oil varnishes as a vehicle and including dryers, antioxidants and pigments. Where the cover film **40** comprises a polyolefin, such as polyethylene, or polypropylene, the so-called "diene" or glycol type inks, which are compatible therewith may also be utilized.

Instead of diluting the emulsified resin particles in an aqueous dispersion of finely divided clay or pigment, it is possible to apply a discontinuous layer of the emulsified resin particles over a previously applied thickness of finely divided clay particles. The discontinuous layer of emulsified resin particles may also be applied directly on the paperboard surface itself. In this latter event, the composition of the coating applied by roller **50** will comprise a suitably diluted water solution of the selected emulsified resin particles. As before, the coating is passed through oven **58** to remove the water content and thereafter rolled by passing through the calender rollers **60** or otherwise reduced to a thickness, this time to comprise from 0.25 to 4 lbs. per thousand square feet of paperboard surface area. Where the emulsified resin particles are not diluted through the finely divided clay pigment, more of the emulsified resin particles are available for contact with the molten resin constituting the cover film **40** and which explains why lower amounts of emulsified resin particles can be utilized in this modification. The maximum amount, on the other hand, is determined by the thickness of the coating which can be applied without detrimentally affecting the porosity of the coated paperboard.

From the above description, it will be apparent that all of the recited objects, advantages and features for the invention have been demonstrated as obtainable in a convenient, simple and highly practical, economical manner. It will be further understood, of course, that many changes, variations, and/or rearrangements of the steps of the process and components of the described coating compositions may be had in the practice of the invention, the limits of which are defined by the appended claims.

Having described my invention, I claim:

1. In the process of packaging objects by positioning the object on one surface of an air pervious sheet of paper, depositiong a molten film of resin over said surface and the objects positioned thereon, and evacuating the air from between said surface and film through the paper sheet, the improvement which comprises first coating said surface of the paper with a thickness of finely divided pigmentary material containing an amount of resin particles to which said film will adhere and which amount is insufficient to inhibit the evacuation of air through the paper sheet.

2. The process of claim **1** wherein the molten film comprises cellulose esters and the resin particles in the finely divided pigmentary material are acrylic resin.

3. The process of claim **1** wherein the molten film comprises polyolefin and the resin particles in the finely divided pigmentary material include polyolefinic resin.

4. In the process of packaging objects by positioning an object on one surface of an air pervious sheet of paper, depositing a molten film of resin over said surface and the objects positioned thereon, and evacuating the air from between said surface and film through the paper sheet, the improvement which comprises first coating said surface of the paper with an aqueous dispersion of finely divided pigmentary material containing from 18 to 40% by weight of emulsified resin particles to which said film will adhere, removing the water therefrom and leveling the solids to a thickness in the order of 2–4 pounds per 1000 square feet of coated surface area which is insufficient to inhibit the evacuation of air through the paper sheet.

5. In the process of packaging objects by positioning an object on one surface of an air pervious sheet of paper, depositing a molten film of resin over said surface and the objects positioned thereon, and evacuating the air from between said surface and film through the paper sheet, the improvement which comprises first coating said surface of the paper with an aqueous dispersion of emulsified resin particles to which the molten film will adhere on setting, removing the water and leveling the deposited resin particles to a discontinuous film having a thickness sufficient to promote adhesion of the molten film of resin to the paper surface and insufficient to inhibit the evacuation of air through the paper sheet.

6. The process as claimed in claim **5** wherein the resin particles of the discontinuous film have a thickness in the order of .25 to 4 pounds per 1000 square feet of coated paper surface.

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