Dec. 18, 1951 S. W. KOBER 2,579,044

METHOD OF EMBOSSING FILM AND COATINGS PRODUCED FROM HEAT CURABLE ELASTOMERS

Filed July 16, 1949

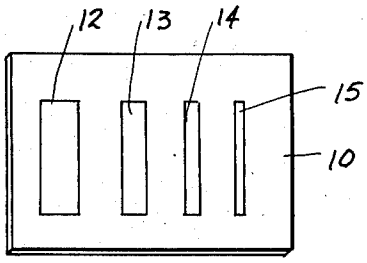


Fig. 1

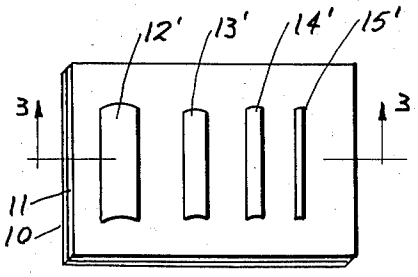


Fig. 2

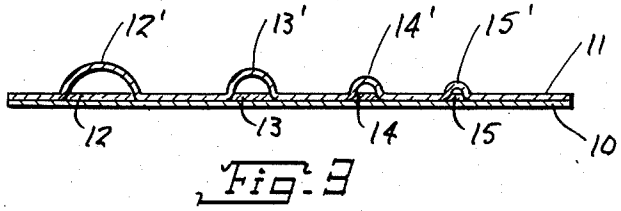


Fig. 3

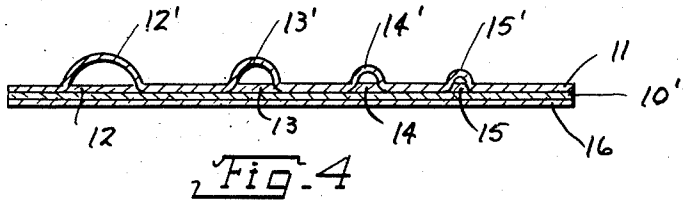


Fig. 4

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Patented Dec. 18, 1951 2,579,044

UNITED STATES PATENT OFFICE

2,579,044

METHODS OF EMBOSSING FILM AND COATINGS PRODUCED FROM HEAT CURABLE ELASTOMERS

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Application July 16, 1948, Serial No. 39,166

1 Claim. (Cl. 117—15)

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This invention deals with embossing, particularly embossing of regular patterns, designs, characters or the like and more particularly embossing of such matter on films and coatings produced from compounds of heat curable elastomers, such as organosols, plastisols and the like, either as plain or decorated unsupported film or as a coating on a plain or printed base.

In the previous art of embossing regular patterns, characters, images and the like, devious ways have been used to obtain raised effects on these materials. In all instances dies of various sorts were use. These took the form of dies engraved in intaglio or in relief. These dies were often used with an opposing male or female part called a counter and between which the material was passed or laid in order to obtain the embossing by means of heat and pressure.

These dies were in the form of rollers when embossing was desired to be done on a continuous web or they were in the flat form when embossing was to be done on single sheets. Embossing of these materials was also accomplished by means of casting the heat curable elastomers such as the organosol or plastisol against a die of some sort, or even against a flexible embossed belt which acted as a die in this case. Heat was then applied to cure the material thus cast. In the embossing of synthetic, thermoplastic coatings or film and of elastomers in general, heat and pressure were both used, whereas in the casting of compounds such as organosols and plastisols, pressure was usually omitted.

In all cases of the above described methods, expensive dies were used and very heavy and expensive machinery was necessary to operate or run such dies.

Those versed in the art know that considerable difficulty is encountered in the process of embossing multi-color printing in the web form because of the necessity for close registry. The difficulty becomes practically insurmountable when the multi-color printing is first coated before embossing. Especially is this the case when the coating is relatively thick, requiring a considerable time for drying or setting before embossing. This is true of single sheets as well as in the web form.

It is a primary object of this invention to provide a method for embossing regular patterns, designs and characters on film and coatings produced from heat curable elastomers, such as organosols, plastisols, and the like without the use of embossing dies.

It is another object of this invention to provide a method for embossing regular patterns, designs and characters on film and coatings produced from heat curable elastomers, such as

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organosols, plastisols, and the like without the use of heavy and expensive embossing equipment.

It is another object of this invention to produce embossings of pre-determined designs and characters as for example; Braille characters on cured elastomers, such as organosols or plastisols by employing the conventional printing processes and using an ink suitable to such process, such ink being especially prepared and having gas evolving properties at a temperature range below the curing temperature of the heat curable elastomers, such as organosol or plastisol but not below the initial set of such coatings, the ink having further properties to produce embossings of exceptional fidelity to their printed images, and a well rounded and pleasing feel and appearance.

It is a further object of this invention to provide a method of embossing on these materials which simultaneously incorporates at least one color on the embossing.

It is a further object of this invention to provide a method of embossing multi-color printed unsupported film and multi-color printed and coated material, such as paper and the like, in register without the critical control necessary for such registry.

Other objects will become apparent upon reading of the descriptive specifications and the appended claim.

To carry out such objects I tried printing regular designs and type faces upon a base, such as paper, with inks containing various substances that would expand or otherwise release gases of various sorts when heated and I tried coating this printing with a layer of organosol or plastisol and subjecting the printed and coated base to the curing temperature of the coating which is about 350° F. in order to form an embossing of the printed part on the cured coating, but the results were not entirely satisfactory.

I tried using oil base inks containing drying oils such as bodied linseed and having ground into this ink various proportions of ammonium or sodium bicarbonate or both as leavening agents. Printed specimens using this type of ink were coated after such ink was allowed to dry and also while in the wet state. In both cases the coating was raised or embossed but the embossing on the dried print was full of pinholes, was of unsatisfactory height and showed general lack of smoothness. The embossing on the wet specimen was higher and showed more promise of smoothness but under the influence of heat, the oil vehicle spread, causing the embossing to spread out of proportion with the printed image. Further, I found that oil base inks generally had too much affinity for organosol and plastisol coatings

thus preventing proper expansion of those portions over such parts printed with this type ink. Inclusion of high-boiling volatiles as part replacement of the drying oil content was also unsatisfactory because of variable evaporation tendencies.

Water base inks having incorporated within leavening agents, were more satisfactory, but here, too, embossing had rough pock-marked appearances because of the uneven action of the leavening agent and also because of sticking of the coating to such ink.

I therefore kept on experimenting and invented incorporating in the ink a heat reactive oil-modified phenolic varnish in a hygroscopic mixture consisting of equal amounts of ammonium and sodium bicarbonate and a relatively large amount of diethanolamine in order to render the mixture highly hygroscopic. Corn dextrin was used as the thickener or bodying agent. Such ink proved highly successful because it did not run under heat, began evolving gases or vapors at about 212° F., or about the temperature of initial set of organosol or plastisol coatings, such evolution of gases becoming complete at about 350° F. or the curing temperature of such coatings.

Therefore, to carry out my proposed objects, one form of my invention provides for printing the lines or characters that are desired to be raised or embossed on a base, such as paper, with an ink as outlined above, coating this printed matter with an organosol or plastisol consisting of a vinyl chloride or vinyl chloride-vinyl acetate copolymer resin in a plasticizer, such as a phthalate plasticizer and containing a stabilizer. Such organosols or plastisols may also contain fillers, pigments, dyes, solvents and diluents. The next step provides for heating such printed and coated base to a temperature range sufficient to cause evolution of gases or vapors from the ink and sufficient to cause curing of the coating which is about 350° F.

This process is differentiated from those processes in which a leavening agent is dispersed in a coating or a compound such as rubber or the like, the whole then heated. Embossing or swelling in irregular fashion is obtained by such processes, but this embossing or swelling does not follow a regular, pre-determined pattern and is really not embossing at all but a series of air cells more or less haphazardly distributed. In my proposed method, there is no dispersion of leavening agent in the coating itself, but merely in the printed parts underneath such coating. Further, in the present method embossing is not characterized by a multiple of individual or interconnected air cells but by a single controlled air cell in the same contour as the parts printed with the embossing ink.

This is made possible because of the hygroscopic nature of the embossing ink, presenting a surface on the embossing ink which is lubricated, or otherwise made incompatible with the coating above, thus preventing sticking of organosol, plastisol or like coatings to such surface when heat is applied for the purpose of curing.

When heat is applied, the combined gases and vapors released by the embossing ink will force the fusing and curing coating away from the surface of the embossing ink, such force acting as a unit in a clearly defined space, following a clearly defined contour.

Comparatively large size type faces, designs, characters or the like may be embossed in this way. Generally, however, when embossing larger designs or type faces of the larger or so called poster size, it is advisable to knife-coat the organosol or plastisol to a heavier gauge to prevent bursting of the embossing, since the larger the area to be embossed, the higher the embossing will be.

This, however, is not critical as these materials under heat soon develop great strength and elasticity even in thin sections. For ordinary sizes and up to such sizes as may be designated by seventy-two (72) point bold type, I prefer to use a coating thickness of .005–.010 inch. For larger sizes I prefer to use a coating thickness of .010–.020 inch. For embossing designs containing both large and small areas an intermediate thickness of about .010–.015 inch is preferred.

In the accompanying drawing forming a material part of this disclosure:

Fig. 1 is a perspective view of a base printed with embossing ink according to this invention.

Fig. 2 is a perspective view of a piece of embossed organosol on the base shown in Fig. 1, in accordance with this invention.

Fig. 3 is an enlarged section taken on the line 3—3 of Fig. 1.

Fig. 4 is a sectional view similar to Fig. 3, but illustrating a modified form of the invention.

For a better understanding of the appearance of large and small embossed areas, reference is now made to Fig. 1 wherein 10 represents a base sheet of paper imprinted with embossing ink 12, 13, 14 and 15, 11 a coating of organosol on said base, and 12', 13', 14' and 15' embossed sections in said coating which were embossed in accordance with this invention and drawn to relative heights corresponding with the areas of the embossed matter.

In a preferred form of this invention the process consists of letter-press or typographically printing a flexible material such as paper with an ink consisting of the following:

Formula for letter-press embossing ink

(1)—2.50 parts ammonium bicarbonate
(2)—2.50 parts sodium bicarbonate
(3)—10.0 parts diethanolamine
(4)—3.00 parts oil-modified phenolic varnish
(5)—6.00 parts water
(6)—18.00 parts corn dextrin (white or yellow technical)
(7)—5.00 parts water dispersible pigment or dye (optional)

Procedure for making letter-press embossing ink

Gently heat the ammonium and sodium bicarbonate with the diethanolamine with stirring until first evolution of bubbles.

Cool and add the phenolic varnish, mix well.

Stir in the water and mix until a well broken precipitate forms.

Add the corn dextrin and the pigment or dye, as desired, and grind on a three roller mill.

The above mixture produces a paste in a consistency well adapted to letter-press printing.

After printing the parts desired to be raised with this embossing ink, the paper thus printed is then knife-coated with a plastisol or organosol as shown in the formulas below to a thickness of .005-.010 inch and subjected to a temperature of about 350° F. for one minute.

There are many formulations of organosols and palstisols suitable for knife-spread coating depending upon the color and hardness of the finished film or coating desired.

Below are but a few preferred forms:

PLASTISOL #1

Clear

100 parts polyvinyl chloride
65 parts dioctyl phthalate
2 parts basic lead carbonate

Mix thoroughly.

ORGANOSOL #1

Clear

25.00 parts copolymer vinyl chloride-vinyl acetate
27.00 parts dioctyl phthalate
1.00 part basic lead carbonate
3.00 parts xylol

Grind in mill.

PLASTISOL #2

White

34.00 parts copolymer vinyl chloride-vinyl acetate
43.00 parts dioctyl phthalate
2.00 parts basic carbonate white lead
18.00 parts calcium carbonate
0.50 part stearic acid
2.00 parts titanium dioxide
0.0025 part fast violet oil dye

Grind in 3 roller mill.

ORGANOSOL #2

Black

45.00 parts copolymer vinyl chloride-vinyl acetate
28.00 parts dioctyl phthalate
0.68 part carbon black
1.00 part basic lead carbonate
3.00 parts diisobutyl ketone
14.00 parts toluol
8.32 parts xylol

Grind in pebble mill.

The preferred copolymer vinyl chloride-vinyl acetate resins contain upwards of 85% vinyl chloride.

The parts printed with the embossing ink release their gases, raising the fusing and curing coating over them in a well-rounded manner which conforms exactly to the contour of those parts, which as stated before, may be in the form of lines or characters thus printed with the embossing ink. When the temperature of about 350° F. is reached, the coating will be completely cured and the embossing will have reached maximum height. The embossing will remain in this position after cooling and will be permanent.

The embossing inks may or may not contain pigment or dye as coloring matter. They may be of the water or oil types. The water dispersible pigment or water soluble dye is added last. The oil soluble dye or oil pigment is ground into the phenolic varnish and incorporated as shown in the formula for letter-press embossing ink.

While most pigments of the non-water dispersible type may be used and ground into the varnish, those recommended are the inorganic types such as iron blues, chrome yellows, ceramic colors and those pigments of the organic variety as will withstand a temperature of 350 to 375° F. for about 1–2 minutes without appreciably fading. An example of the latter are the phthalocyanine blues and greens.

Addition of coloring matter to the embossing ink has the effect of imparting color to those parts, designs, characters and the like which are raised or embossed by this embossing ink. For example: If a water dispersible red pigment is added to the letter-press embossing ink, a design or character printed with this ink, the printed parts coated to a pre-determined thickness with a clear organosol or plastisol as above, the whole then heated to a temperature of 350° F. for about one minute, the design or character will appear embossed in red on a clear, transparent or translucent background. The coloring produced on organosol and plastisol film and coatings by such water dispersible pigments and water soluble dyes are fast and unaffected by after-treatment with water.

For production of multi-color, printed, coated and embossed paper and the like, the design proper is printed with as many colors as desired, using conventional letter-press inks readily found on the market. Those parts desired to be raised are printed in register with the design proper using the letter-press embossing ink. The entire printed matter is then coated with an organosol or plastisol as before and the whole assembly heated up to 350° F. in about one minute.

As in the previous case, the coating over those parts printed with the embossing ink will expand and assume a well-rounded and embossed appearance. The color or colors in register with the embossing ink will be unaffected and the coating over such color or colors will be unaffected and both will remain flat against each other and against the base each is on.

It has been found that this process produces a raised effect on unsupported film and coatings made from organosols and plastisols, etc. which is highly desirable and one which is closely similar to an effect produced by the use of hot embossing dies or by means of casting against molds of various sorts.

This process presents a saving in the making of costly dies or molds and is not only a method of securing greater depth of embossing than is possible by other types of embossing media, but is also a method of securing unerring registry of embossing with multi-color printed matter on the above types of film and coatings.

It is understood that what has been described is but a preferred form of this invention and many variations in procedure are possible. Other hygroscopic amines or hygroscopic components may be used in conjunction with the embossing ink. However, I do not prefer to use glycerine as the hygroscopic component because of the excessive leavening action produced in stored batches of this ink. If circumstances are such that the leavening action of stored batches is not important, then I would say that glycerine is excellent as the hygroscopic component. Likewise, other printing processes may be employed, and other flexible material other than paper may be used for printing on. Coating, too, may be done by any other method.

The rotogravure process of printing may be employed in my invention for the production of printed, coated and embossed paper and the like in the web form.

When employing the rotogravure or intaglio method of printing, those parts desired to be raised or embossed are printed with the letter-press embossing ink substantially thinned with water. Experienced rotogravure pressmen are easily able to judge when an ink reaches suitable consistency to be taken up by an etched rotogravure printing roller. In general, a suitable rotogravure embossing ink is made by diluting

the letter-press embossing ink 50–100% by weight with water.

The web desired to be coated and embossed is treated substantially as in the letter-press method. The parts desired to be raised or embossed are printed with the rotogravure embossing ink. The web thus printed is led to a knife-coater where a predetermined thickness of an organosol, plastisol or the like is applied. The web thus printed and coated is next led to a heating device which may be either of the open or closed type.

As in the case with the letter-press method, this process will produce blind embossing, that is: colorless or colored embossing on a similar colorless or colored background, a single color embossing on a transparent, translucent or contrasting background and embossed in register with multi-colored figures, designs, characters and the like. As stated before, the rotogravure process achieves these results on a continuous web or roll rather than on single sheets.

As in the letter-press method also, it is preferred to print the design proper first. This is done by employing conventional rotogravure ink, the types depending on the choice of flexible material for printing. All desired colors are printed first, and lastly those parts desired to be raised or embossed are printed with the rotogravure embossing ink.

The embossing ink may be used to print on metal foil as well as paper. Interesting effects may be produced on this type of printing base by use of my invention. Large, transparent, colored or colorless embossed areas may be produced through which the light reflection of the metal foil will show beneath.

Interesting effects are obtained also by using cellophane as the printing base. Since cellophane is more or less non-porous, coating of this and similar non-porous surfaces should be done as soon as possible after printing with the embossing ink. This is necessary because of the hygroscopic nature of the embossing ink and to prevent consequent off-setting.

While an organosol or plastisol coating is more or less easily stripped or peeled from its base, it is very easily stripped from such bases as metal foil and cellophane. Organosol or plastisol coatings stripped from cellophane will have a highly lustrous finish resembling patent leather.

In my invention not only is there produced an embossing in relief on the side opposite the side printed with the embossing ink, but there is also produced an intaglio imprint on the side of the coating adjacent to the side printed with the embossing ink. Films of relatively thick gauge may be processed according to my proposed method and stripped from cellophane or similar highly polished surfaces. Color may be imparted to the intaglio impression. By use of metallic powders as the coloring medium in the embossing ink, heavy gauge films may be produced which resemble artificial leather stamped or engraved with metallic leaf.

It is recommended that metallic powders for this purpose be incorporated in the embossing ink merely by mixing. The quantity used should be about 5–15% by weight of the ink used, depending on the brilliance desired.

In my method it is also possible to produce any of the above described types of embossed film without intaglio imprint but with smooth back.

To produce such embossed film with smooth back, I follow the procedure as described below,

reference being had to Fig. 4. A layer 10' of organosol, plastisol or the like is applied in a pre-determined thickness to a smooth, temporary base 16 such as metal foil or thin gauge strip or spring steel, and heated to a temperature to cause partial curing. Printing 12, 13, 14 and 15 is carried out as before described on the partially cured coating 10' on the base 16. A layer 11 of similar material as the partially cured base 10' is then applied in a predetermined thickness over such partially cured and printed base 10'. The temporary base 16 with such composite coating is then subjected to a temperature of about 350° F. for one minute or sufficient to cause release of gases or vapors in the embossing ink and sufficient to cure the coating 10' and 11 as a whole. After coating, the complete film 10', 11 is stripped from the temporary base 16. The resulting film 10', 11 will have the printed portion within its walls, the embossing in relief, and smooth back.

Coating of the printed sheets may be done by reverse rollers coater as well as by knife-coater. Calender coating also may be employed. Calender coating may be done either hot or cold but in either case the calendered sheet or web must be subjected at some stage to sufficient heat to cause the release of gases or vapors from the embossing ink and also cure the overlying coating.

Heating may be done by running the sheet or web through an oven kept at a temperature of about 350° F. or heating may be done in the open by running the sheet or web over electrically heated coils or plates. When heating is done in the open, provision may be made for heating both top and bottom of the web. For heating of the top surface a bank of infra-red lamps may be employed.

Various other uses may be made of this type of printed, coated and embossed matter. The coating acts as a protection for the printed matter underneath and although the embossing is soft and flexible, the natural resiliency and springiness of the coating will give a certain firmness and permanence to the embossed outline or part.

Such matter may be used for advertising literature in which certain parts may be wished to be emphasized by means of raised or embossed effects.

Novel effects may be produced on greeting cards by having an embossed transparent coating over regular printed matter.

Durable, water-proof relief maps may be produced cheaply by my method.

One highly novel and unique use to which this process may be put is in the production of a form of Braille printing. This is merely done by printing a sheet of paper with dots of predetermined size, then coating with an organosol or plastisol, subjecting it to a temperature sufficient to release the gaseous forming substances in the embossing ink and also sufficient to cure the overlying coating. The result will be quite similar to the Braille printing as produced today by means of dotted embossing plates. The new system will have the added advantage of being compressible, thus reducing the thickness of the average work produced in Braille. Furthermore, even tissue paper may be printed and embossed in this way, thus obviating the use of heavy paper or cardboard. In the inventor's opinion this is one of the best uses to which this process may be put. It is one in which books, periodicals, etc. may be produced for the blind in un-

limited quantities, thus affording these handicapped people a means of rehabilitation, instruction and entertainment now of necessity made prohibitive by factors of cost, bulk and production difficulties.

Another use to which this process may be put is that in decorative papers. Highly resistant and durable wall papers having the desirable embossed effect may be produced. Wall papers of this nature have the added advantage of a washable protective coating which may be in a considerable thickness thus affording ample protection for the printing underneath.

Another use to which this process may be put is in the production of multi-color printed and embossed shower curtains and other forms of unsupported film. The process for the manufacture of this type of printed and embossed in register film consists of printing a metallic carrier with an embossing ink as described, in the form of lines or patterns which are to be the final embossed parts, these parts being printed in register with all other colors desired, then coating with a transparent or translucent composition of plastisol or organosol, running through a heating oven at a temperature sufficient to cause release of the gaseous product in the embossing ink and also sufficient to cause curing of the overlying coating, allowing to cool and then stripping the film from the metallic carrier. In the manufacture of multi-color printed and embossed unsupported film, where stripping from a carrier is employed, the printing ink forming the design proper must be of such a nature as to be compatible with the plastisol of organosol coating over it. Such an ink must have less affinity for the carrier than for the organosol coating. An ink of this nature and suitable for the rotogravure method of printing may consist of a resin such as polystyrene dissolved in a solvent such as xylol and containing a plasticizer and pigment or other coloring matter. Another type of ink may consist of a vinyl-chloride or vinyl chloride-vinyl acetate copolymer dissolved in a suitable solvent and containing a plasticizer, pigment or other coloring matter. All of the printed matter except the lines printed with the embossing ink will be transferred to the unsupported film. The embossing ink will release the gases necessary for embossing their image and part will remain on the metallic carrier as a residue. This residue may easily be washed off with water and the metallic carrier may be used over and over again as wanted.

In connection with the production of multicolor printed and embossed in register shower curtains and other unsupported film produced from organosols, plastisols and the like, the silk screen method of printing may be used to advantage, since by this method exceptionally heavy ink films may be squeegeed through the silk screen.

As in the case with the letter-press and rotogravure methods, all desirable colors are printed on a suitable base using conventional silk screen printing inks. Those parts desired to be raised or embossed are printed in register with the design thus printed. This latter printing may be done by the silk screen method also, using the letter-press embossing ink thinned by addition of about 3–10 parts of water to the entire formula.

Coating and heating are carried out as previously. Upon cooling, the printed and embossed in register film or coating may be stripped from its base.

Another practical use of this process can be made by individuals wishing distinctive calling cards, letterhead stationery, mail box names and numbers, signs and posters. For this purpose the embossing ink is made quite fluid by addition of water in order to be used with an ordinary steel pen, quill or small artist's brush. Coating of this writing may be done by any smooth piece of wood or iron acting as a knife scraper over a stencil. The entire written-on and coated paper or card is then subjected to heat as previously. This heating may be done in the home oven, raised to a temperature of about 350° F. or over an electric heater where the individual may observe the progress of embossing and curing and use judgment in regard to the degree to which these are to be carried.

While I have illustrated and described the preferred embodiments of my invention, it is to be understood that I do not limit myself to the precise constructions herein disclosed and the right is reserved to all changes and modifications coming within the scope of the invention as defined in the appended claim.

Having thus described my invention, what I claim as new and desire to secure by United States Letters Patent is:

The method of producing embossed forms on a surface which comprises letter press printing on a paper base with a hydrophilic ink which is composed of 2½ parts ammonium bicarbonate, 2½ parts sodium bicarbonate, 10 parts diethanolamine, 3 parts oil-modified phenolic varnish, 18 parts dextrin, 6 parts water and pigment, said ink being hygroscopic, allowing inked portion to accumulate atmospheric moisture upon its surface, applying over the printed paper base a layer of vinyl chloride plastisol, said vinyl chloride plastisol being composed of a paste of substantially 100 parts vinyl chloride resin, 65 parts dioctyl phthalate plasticizer and 2 parts basic lead carbonate stabilizer, said plastisol setting at approximately the temperature of water vapor at 212° F., and curing at approximately 350° F., and then subjecting printed and coated paper base to a temperature of 350° F. to cause transformation of accumulated atmospheric moisture upon said ink into gases for embossing said layer of vinyl chloride plastisol while it is setting, said temperature of 350° F. also releasing additional gases from the bicarbonate and holding combined gases under pressure until the vinyl chloride plastisol is cured in order that said vinyl chloride coating is soft and flexible and is embossed with a permanent and resilient facsimile in relief.

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