METHOD OF EMBOSsing THERMOplastic Fabrics


Application January 7, 1955, Serial No. 480,659

Claims priority, application Great Britain January 12, 1954

6 Claims. (Cl. 18—56)

This invention relates to fabrics, and in particular to the art of embossing fabrics.

I have found that valuable embossed effects can be produced on fabrics containing thermoplastic fibres (i.e. staple fibres or continuous filaments) by pressing the fabric in a temporarily softened condition against a pattern by means of fluid pressure acting on a membrane impermeable to the fluid and in contact with the fabric, and subsequently removing the fabric from contact with the pattern after hardening it sufficiently to enable it to retain the pattern impressed upon it. The fluid employed may be air at atmospheric pressure, the membrane may be a thin sheet of rubber, and the pressure may be caused to operate by suction applied through perforations or pores in the pattern and thence through the interstices of the fabric to that surface of the membrane that is in contact with the fabric. The temporary softening may be effected by heating the fabric, preferably in the presence of a liquid having a softening action at the temperature to which it is raised. It is generally desirable to heat the pattern and the necessary heating of the fabric can be achieved by bringing it into contact with the hot pattern. The hardening may be effected by cooling the embossed fabric and/or removing any softening liquid applied thereto.

Apparatus suitable for carrying out the process of the invention may comprise, in combination, the following elements: a perforate (or porous) support for the pattern; one or a plurality of perforate (or porous) patterns supported thereon; means for holding a layer of the fabric to be embossed immediately above the pattern; a substantially air-impermeable elastic membrane of larger area than said support; means for holding said membrane immediately above, and in contact with, the fabric; enclosing means such that suction applied to the underside of the perforate support operates through said support, through the pattern and through the fabric, to draw the membrane down and cause it to conform to the configuration of the pattern (thereby causing the fabric to assume this configuration); means for applying said suction; and means for heating the pattern and/or the fabric to such a temperature that permanent deformation of the fabric occurs under the pressure applied by the membrane.

The accompanying drawings show in sectional elevation the arrangement of parts in three successive stages in the carrying out of the process of the invention using a preferred form of apparatus.

Referring to Figure 1, the open-mouthed vacuum box 10 has a suction pipe controlled by a quick-acting valve 12 and communicating with a vacuum tank (not shown) in which a vacuum is maintained by an automatically operated, electrically driven suction pump. Within the vacuum tank are wooden blocks 13 stands a perforated metal plate 14, $\frac{3}{8}$" thick, the perforations 15 of which are $\frac{1}{2}$" holes the centres of which are $\frac{5}{16}$" apart. On the edge 16 of the mouth of the vacuum box rests a rubber gasket 17. The perforated plate 14 supports the pattern 18, which is a perforate metal structure. (The perforations are not shown.) An electric blanket heater 19 is mounted on rails (not shown) above the vacuum box, so as to be capable of being quickly moved into and out of position directly above the box. Figure 1 shows the heater in position above the box and heating the pattern by radiation.

When the pattern has acquired the appropriate temperature (which will generally be about 150 to 200° C., according to the nature of the material of the fabric and of any softening liquid employed thereon), the fabric is laid across the mouth of the vacuum box and held under light tension while the heater is moved away and there is brought into position above the vacuum box a frame across the under-surface of which is stretched a substantially air-impermeable elastic membrane, e.g. of thin vulcanized rubber sheet. The arrangement is now as shown in Figure 2, where the fabric 20 is shown in position with the frame 21 carrying the elastic membrane 22 above it.

The frame is now brought down on to the fabric where this passes over the gasket 17, resting on the edge 16 of the vacuum box. By means of quick-acting clamping means (not shown) the frame is clamped in position. The valve 12 in the suction pipe 11 is then quickly opened, so placing the vacuum box in communication with the vacuum tank. This causes the membrane to be suddenly drawn down towards the perforated plate 14 so as to urge the fabric suddenly down and press it into overall contact with the pattern 18. The position is now as shown in Figure 3.

The assembly is now allowed to cool (which may be helped by directing a blast of cold air on to the upper surface of the membrane) after which the frame, and with it the membrane, is removed, and the embossed fabric is stripped from contact with the pattern.

The following examples illustrate the invention:

**Example 1**

The apparatus employed was that specifically described above.

The fabric to be embossed was a plain-woven fabric the warp of which consisted of 84 ends per inch 140-denier cellulose acetate yarn, and the weft of 66 ends per inch 150-denier.

The pattern was a woven wire gauze of 16 meshes to the inch, cut to fit loosely within the box. The gauze was supported on a gasket of asbestos paper that rested upon the perforated plate or "false bottom" of the box, which was supported at such a height within the box that the upper surface of the pattern was nearly flush with the sides of the box.

The fabric was soaked in water so as to facilitate heat-softening. The heater was brought into position and the gauze pattern raised to a temperature of about 130° C. The heater was then quickly moved out of position and replaced by the frame carrying the membrane. The fabric was laid over the pattern with its edges projecting beyond the edges of the vacuum box. The frame was quickly brought down and clamped in position so as to hold the fabric against the edges of the box. The valve in the vacuum pipe was opened so as to establish immediate communication between the space under the perforated support and the vacuum tank.

Under the suction applied, the membrane was forced by the pressure of the atmosphere into close contact with the surface of the fabric, and forced the fabric to take the configuration of the pattern. The heat imparted by the pattern to the fabric in the presence of the water so softened the cellulose acetate of the fabric as to render
the deformation permanent. Shortly after opening the suction valve, the fabric was cooled by directing a jet of cold air on to the surface of the membrane, the vacuum valve was closed, the frame was unclamped and swung away from the box, and the cycle could then be repeated.

The fabric was found to be embossed with a pleasant wrinkle effect, which withstood washing in hot, soapy water.

Example 2

The process was carried out as in Example 1, except that: the pattern consisted of a medallion in filigree work resting on a porous asbestos sheet on the perforated plate of the vacuum box; the fabric before embossing was padded with a 4% aqueous solution of diethylene glycol diacetate to leave 100% based on the fabric weight of said solution in the fabric; and the pattern was heated to about 180°C. The time of contact of the fabric with the pattern was about 10 seconds. The pattern was reproduced with remarkable faithfulness on the fabric and, as before, the fabric could be washed without destroying the pattern.

Many other kinds of pattern can easily be provided. Interesting effects, for instance, can be obtained by using metal plates perforated in various ways. More elaborately, patterns can be obtained by casting in metals, e.g. low-metal alloys. Heat-resistant, non-metallic materials can also be used, e.g. coarsely woven fabrics of glass-fibre, perforated sheets, mouldings or sintered shapes, of heat-resistant plastics, e.g. polytetrafluoroethylene, or heat-resistant laminates, e.g. of glass-fibre impregnated with a thermostetting silicone resin. Whatever the nature of the pattern, provision must, of course, be made, for instance by perforations or pores in the pattern, for transmitting the suction to the under-surface of the membrane.

For the membrane, thin vulcanized natural rubber is very suitable, but other sheet materials having some degree of rubber-like elasticity may be used. Among these are synthetic rubber sheets, e.g. sheets of neoprene, the nitrile synthetic rubbers and the polysulphide synthetic rubbers, and also the so-called silicone rubbers, which have the advantage of relatively high heat-resistance. The membrane itself may be heated provided that it be not damaged by too high a temperature.

A higher degree of thermoplasticity may be temporarily induced in the fabric by soaking it in a liquid having a greater softening effect than those referred to above at the temperature to which the pattern is to be heated. For cellulose acetate, such liquids include concentrated aqueous solutions of alcohols, e.g. 80% aqueous methanol, ethanol, isopropanol, and tertiary butanol.

Other methods can be adopted for heating the pattern. It may, for example, be heated by conduction, for instance from electric elements incorporated in it, or located close to it in the perforate support. Another alternative is to heat both the fabric and the pattern by steam. Steam may, for example, be circulated through the space in the vacuum box, this space being provided with inlet and outlet valves for the steam, which can be closed before applying the suction. I have also obtained useful results by radiation-heating of the fabric instead of the pattern, the fabric in this method being laid in position over the pattern before the heating is commenced. I have, however, found that the rapid heat-transfer that occurs when the fabric is drawn into contact with an already heated pattern is of great advantage, and enables sharper impressions to be formed on the fabric without danger of embrittlement.

Another variant of the process is to apply positive air-pressure to the membrane instead of relying on atmospheric pressure. When this method is adopted, pressures considerably higher than one atmosphere, e.g. from 2 to 5 atmospheres or even more, can be applied, and the suction means can be dispensed with. Instead of using air as the pressure-applying fluid, other gases, vapours, or even liquids, e.g. steam or hot water, can be employed.

The invention has been described above as a batch operation. It can, however, be carried out in a semi-continuous or continuous way. Thus, for example, if it is desired to provide a fabric embossed with patterns of different designs at intervals, successive lengths of the fabric can be drawn off from a roll and subjected in turn to embossing in apparatus of the kind described above.

For continuous operation an endless perforate flexible driven metal band or a perforate metal drum may be used. Such a band or drum may carry perforate medallions or other pattern elements, or the perforations may themselves provide the pattern. Or again a suitably patterned perforate or porous patterning belt may be drawn continuously between the fabric and the drum. Fabric from one supply-roll and rubber sheeting from another may be drawn off by the movement of the band or drum so that the fabric lies between the rubber sheet and the belt or drum surface. Suction is applied through the perforations in the drum or belt, and thence through those in the pattern and through the fabric, to draw the membrane into close contact with the fabric. Over part of its path the pattern and/or the fabric is (or are) heated, and over another part of the path cooling is effected to enable the fabric to be drawn away from the pattern without blurring the figure embossed upon it. Suitably located take-up rolls are provided for the rubber sheet and for the embossed fabric. Instead of drawing off the rubber sheet from one roll and winding it on to another, this sheet may be in the form of an endless driven band. To avoid damaging the figure of the fabric, this is preferably taken up on pin-rolls engaging only the edges. In working continuously or semi-continuously, positive fluid pressure may be used as described above.

By the methods described, fabrics can be embossed without undue stiffening. For some purposes, however, stiffening is not undesirable, and the invention includes embossing, and at the same time stiffening, the fabric. When this effect is desired, there may be used, instead of water or the other softening liquids described above, a liquid having a greater softening action, or even a solvent action, on the fabric. Such liquid may contain a true solvent, e.g. acetone, for the cellulose acetate. High-boiling solvents, e.g. diacetone alcohol, ethyl lactate, cyclohexanone or cyclopentanone may also be used.

Moreover, and the softening liquids may contain a plasticizer for the cellulose acetate, e.g. dimethyl phthalate, diethyl phthalate, dimethoxyethyl phthalate, methylphthlyl ethyl glycolate, ethyl-phthlyl ethyl glycolate, butyl-phthlyl ethyl glycolate, dibutyl tartrate, tricapron, tripropionin, tri-chlorehyl phosphate and acetyl triethyl citrate. The fabric may also be impregnated with plasticizer before embossing.

The process of the invention also has applications in packaging. Thus, for instance, a plasticized fabric may be embossed to provide recesses to accommodate small articles, and small articles may be affixed to a show-card by the process of the invention. For this purpose the card which is porous is supported by the perforate support, and in turn supports the articles to be enclosed, and either the fabric is rendered adhesive, or adhesive is applied to the card in such a way as not to destroy its porosity.

The process of the invention may be applied to fabric knitted as well as to woven fabrics. It has given particularly valuable results with fabrics of cellulose acetate yarn. The yarn may be dry-spun, wet-spun or melt-spun. The process of the present invention may be employed on other thermoplastic fabrics and on mixed fabrics, e.g. fabrics containing cellulose acetate yarn (either of continuous filament or staple fibre) in admixture with yarn of other materials, e.g. yarns of cotton, linen, regenerated cellulose or other non-thermoplastic, fibre-forming material. Such other yarns include continuous-filament as well as staple-fibre yarns. The non-thermoplastic yarn may with advantage be a high-tenacity yarn of regenerated cellulose made by complete saponification of cellulose acetate yarn.
that has been stretched to high tenacity, e.g. 6 to 8 gms. per denier, in steam or hot water. As a further alternative, especially when stiffened fabrics are required, the fabric treated may be composed of a non-thermoplastic fibre and may be coated with cellulose acetate, preferably plasticized. The proportion of thermoplastic material in a mixed or coated fabric may with advantage range upwards from about 50% by weight, e.g. it may be 50 to 80%.

Cellulose acetate has been instanced above as the thermoplastic material, but other thermoplastic materials may constitute the fibre-forming material of the fabric to be embossed, or may be employed as coatings on a non-thermoplastic fabric. Such other thermoplastic materials include other organic esters of cellulose, e.g. cellulose propionate, cellulose acetate-propionate and cellulose acetate-butyrurate, thermoplastic, fibre-forming vinyl compounds, e.g. polythene, polyvinyl chloride, polyvinyl chloride-acetate and copolymers of vinylidene chloride with vinyl chloride, and fibre-forming thermoplastic condensation polymers such as polyhexamethylene adipamide, polyaminocaproic acid and other nylon, polyesters such as polyethylene terephthalate, and polyurethanes.

Fabrics of non-thermoplastic fibre, in the absence of any thermoplastic material, can be embossed by the process of the invention, and, if suitable resinous or resin-forming materials are present, effects sufficiently permanent to be useful can be obtained. Thus, for example, cotton or regenerated cellulose fabrics can be embossed by the process of the invention after impregnation with a thermosetting synthetic resin or components that form such a resin when heated. The fabric may, for instance, be impregnated with a resin-forming condensation product of formaldehyde and urea or melamine, in the presence of a suitable catalyst, as is done in treatments directed to producing crease-resisting finishes. Or a heavier coating of the resin or resin-forming constituents may be applied to the surface of the fabric, as is done when glazed resin finishes are required. The embossing process of the invention can be combined with a local or overall colouration of the fabric.

Having described my invention, what I desire to secure by Letters Patent is:

1. A process for embossing a fabric of thermoplastic material which comprises temporarily softening said fabric by contacting it with a heated perforate pattern while it is wet with a liquid that assists softening at elevated temperatures but is not a softening agent at atmospheric temperatures, while the fabric is in a softened condition forcing it into close overall contact with said pattern by sucking down upon it an elastic membrane, the suction operating through the perforations in the pattern and the interstices of the fabric, hardening it by cooling, and separating it from the pattern.

2. Process according to claim 1, wherein the fabric is composed of fibres of a thermoplastic organic-acid ester of cellulose.

3. Process according to claim 1, wherein the fabric is composed of fibres of cellulose acetate.

4. Process according to claim 1, wherein the fabric is composed of fibres of a thermoplastic organic-acid ester of cellulose and the temporary softening is effected while the fabric is wet with a volatile aqueous liquid.

5. Process according to claim 1, wherein the fabric is composed of fibres of cellulose acetate, and the temporary softening is effected while the fabric is wet with water.

6. Process according to claim 1, wherein the fabric is composed of fibres of cellulose acetate, and the temporary softening is effected while the fabric is wet with an aqueous solution of diethylene glycol diacetate.

References Cited in the file of this patent

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Inventor(s)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,354,916</td>
<td>Hurt</td>
<td>Aug. 1, 1944</td>
</tr>
<tr>
<td>2,513,785</td>
<td>Browne</td>
<td>July 4, 1950</td>
</tr>
<tr>
<td>2,660,757</td>
<td>Smith et al.</td>
<td>Dec. 1, 1953</td>
</tr>
</tbody>
</table>