PROCESS FOR CONSTRUCTING TUFTED CARPETS AND RUGS AND BONDING AGENTS USEFUL THEREIN

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Filed Apr. 4, 1968, Ser. No. 718,870
Int. Cl. C08F 29/12
U.S. Cl. 260—28.R 10 Claims

ABSTRACT OF THE DISCLOSURE

Tufted carpets and rugs of fibrous strands are constructed by singeing the back of a tufted web, and preheating the back of the tufted web, applying a particulate bonding agent to the preheated web, heating the bonding agent above its fusion temperature and applying a pressure sufficient to force the bonding agent over the back of the tufted web and into the fibrous strands.

A novel composition utile as the bonding agent comprises a hydrocarbon polymer of a lower alkene, such as polyethylene, having a melt index less than 150, an ethylene/mono-unsaturated ester copolymer having a melt index greater than 100 and a wax having a melting point of from 75° to 95° C.

BACKGROUND OF THE INVENTION

Although of fairly recent vintage, tufting has become the dominant method of constructing carpets and rugs.

Tufted carpets and rugs are typically manufactured in two operations. A tufted pile is first created by sewing continuous strands comprised of a plurality of fibers into a backing which is usually woven from jute, hemp, kraft cord or cotton, or plastic and may also be at net or a random fiber mat. This backing or "scrim" holds the tufted pile which is essentially a series of loops in some predisposed pattern. The result, at this stage, is a fairly limp tufted web which is then coated on the back with a bonding agent to permanently bond the tufts to the backing. A secondary scrim may also be added to lend additional "hand" and dimensional stability to the finished product.

Bonding agents today are typically a latex formulation applied as a wet coating over the back of the tufted web. While this results in acceptable bonding, costly and time consuming drying steps must then be performed before the manufacturing operation is complete. Such steps have, however, been deemed necessary to firmly bond all fibers which comprise the strands to preclude fibers from withdrawing from the carpet or web and forming into unsightly balls or " pills." The phenomenon of pilling has been observed to be most prevalent in tufted carpets or rugs constructed of strong filaments such as nylon.

The object of this invention, therefore, is to provide an improved process for manufacturing tufted carpets and rugs which eliminates the costly drying steps associated with the use of latex bonding agents and which provides finished carpets and rugs of good pilling resistance.

SUMMARY OF THE INVENTION

A new and improved continuous process for producing tufted carpets and rugs has been developed which comprises passing the back of a fibrous tufted web through a singeing zone to remove fiber fuzz from the back of the fibrous tufted web, preheating the back of the tufted web to a temperature below the fusion temperature of the tuft fibers, applying a particulate bonding agent to the preheated back of the tufted web, heating the bonding agent to a temperature above the fusion temperature of the bonding agent, applying a positive pressure to the bonding agent to cause flow of the bonding agent over the back of the web and penetration of the fibrous tufts and cooling the back of the web to set the bonding agent. As an alternative, a secondary scrim may be applied to the heated bonding agent prior to or simultaneously with the application of pressure.

In another aspect of this invention a new and novel resinous bonding agent composition utile in the above process has been found which comprises a blend based on the total weight of the bonding agent, from about 70 to about 90 percent by weight of hydrocarbon polymer of a lower alkene having a melt index measured at 44 p.s.i. and 190° C. of less than about 150 g/dm./min., from about 10 to about 30 percent by weight of an ethylene/monounsaturated ester copolymer having a melt index measured at 44 p.s.i. and 190° C. greater than about 100 g/dm./min., and from 0 to about 15 percent by weight of wax having a melting point of from about 75° to about 95° C. For each 100 parts by weight of this resin bonding agent blend there can be added up to about 33 parts by weight of a filler.

IN THE DRAWING

The attached drawing is a schematic illustration of the method constructing carpets and rugs according to one aspect of this invention.

DESCRIPTION

This invention relates to an improved process for constructing tufted carpets and rugs and to a new and novel bonding agent composition useful in such process.

With reference first to the attached drawing, the improved process generally comprises passing the back of a tufted web through a singeing zone to remove fibrous fuzz, preheating the back of the web to a temperature below fusion temperature of the fibers, applying a particulate bonding agent to the preheated back of the web, heating the bonding agent to a temperature above its fusion point, applying a positive pressure to the bonding agent to cause flow over the back of the web and penetration of the fibrous strands which comprise the tufts and cooling the back of the web to set the bonding agent. As an alternative, a second backing may be applied before setting the bonding agent to lend additional "hand" to the finished rug or carpet.

As mentioned above, the first step in constructing tufted carpets and rugs which generally precedes the practice of this invention is the insertion of continuous strands of compacted fiber or "fiber bundles" into a backing or "scrim" before applying a bonding agent to the back of the web to lock the tufts in place. It has been found, that such fibrous strands contain substantial amounts of fiber fuzz which impedes the flow of a molten bonding agent into the strands. It has been found according to the present invention that if this fiber fuzz is singed off by the application of a flame or hot air stream that fiber bundle penetration will be substantially increased, other factors being constant.

With particular reference to the drawing, singeing may be accomplished by passing the tufted web through in a pair of idler rolls to maintain tension and then through the singeing zone where fiber fuzz is removed by the action of the impinged flame or blast of hot gas. Radiant heat has been tried and found ineffective as it tended to fuse the surface of the fibrous strand thus further impeding penetration.

In the second step of the novel process of this invention, the singed tufted web is passed through a pre-heating zone where the back of the tufted web is heated until it is warm to the touch or to a temperature of about 40° to about 70° C., but below the fusion temperature of the fibers. The importance of this step will be more clearly set forth below.
The heating units useful in this pre-heating step include amongst others, radiant heat devices and the like, and should be sized to provide at least about one third of heat output of the main heating unit. The residence time of the web in this zone will, of course depend upon the pre-heating unit used. A bank of radiant heaters having an output of about 8 kilowatts positioned about 5 inches above the back of the 12 inch wide tufted web moving at a rate of five feet per minute has been found effective for pre-heating nylon filament tufts. As will be understood however, these requirements are flexible and that residence time will vary depending on the nature of the synthetic fiber, the output of the heat source and its position relative to the tufted web as well as rate at which web is passed through the pre-heating zone.

A heater web is then passed through the zone wherein in a particular bonding agent composition which is preferably a powder is applied to the heated back of the tufted web by a variety of means including the vibrating plate and hopper arrangement shown in the drawing. While other mechanical devices for applying the particular bonding agent may be used, they should act to evenly distribute the particulate bonding agent over the pre-heated web to an average weight of about 5 ounces to about 35 ounces per square yard of tufted web to obtain good tuft lock and 100 percent fiber penetration and allow for the addition of a secondary backing.

The pre-heated web and applied bonding agent are then passed through a heating zone wherein the bonding agent is raised to a temperature above its fusion point and preferably above its melting point where such bonding agent will generally “pool” into beads on the back of the tufted web and begin to penetrate the fibrous strand. For good operating compatibility with the pre-heating zone heat output, this main heating zone should generally be from about 2 to about 5 times the heat output of the pre-heating zone.

It is in this connection that the pre-heating serves an important role. First, pre-heating provides a warm depression surface rather than a heat sink to promote complete thermal fluidization of the bonding agent and to preclude resistance to bonding agent heating at the web-bonding agent interface. Secondly, it promotes fiber flexibility to increase bonding agent flow into the fibrous tuft: Pre-heating has been found to effectively reduce residence time in the main heating unit by as much as 50 percent all other factors being constant.

After leaving the main heating unit, the tufted web and now fluid bonding agent are passed through a pressure zone which is shown in the drawing as a pair of nip rolls. In this zone there is applied a pressure which is slightly less than that required to crush the tufts but sufficient to force fluid bonding agent uniformly over the back of the tufted web and into the fibrous tufts thereby bonding the tufts to the backing and the fibers of each tuft together.

As shown, the nip roll above the web is preferably cooled to simultaneously set the bonding agent so that the finished carpet or rug can be immediately passed through any desired series of idler and tension rolls to the finished roll for storage.

As an alternative to the above process, a secondary backing or "scrim" may be applied to the web while the bonding agent is fluid to produce a rug or carpet having a double backing and improved "hand." Where a double backing is used, a greater amount of bonding agent may be required since it must also serve the function of bonding the secondary backing of the web.

As another alternative, the finished tufted carpet or rug may have thereto a formed latex or the like to provide inherent cushioning.

The novel resinous bonding agent composition of this invention generally comprises a lower alkene polymer, an ethylene copolymer and desirably a minor amount of a wax having a melting point of from about 75 to about 95° C.

The hydrocarbon polymer of the lower alkenes useful as a component of the bonding agent composition principally contain carbon and hydrogen and includes homopolymers of a saturated hydrocarbon polymer having from 2 to 6 carbon atoms. The lower alkene polymer should have a melt index measured at 44 p.s.i. and 190° C. below about 150 dgm./min. and preferably from about 50 to about 100 dgm./min. The desired lower alkene polymers are those of low crystallinity and low stiffness modulus, and include amongst others polyethylene, ethylene homo- and copolymers.

The preferred lower alkene polymers are ethylene homo- and copolymers having a density of from about 0.910 to 0.935.

The ethylene/mono-unsaturated ester copolymers used in the practice of the bonding agent compositions of this invention are prepared by polymerizing ethylene with one or more mono-unsaturated esters copolymerizable therewith. Copolymerizable mono-unsaturated esters include the vinyl esters such as vinyl acetate, vinyl formate, vinyl propionate, vinyl butyrate and the like as well as alkyl esters of unsaturated acids such as methacrylate, ethyl acrylate, isopropyl acrylate, butyl acrylate, 2-ethylhexyl acrylate, bi-cyclo-heptyl acrylate, 2-methylyaminol ethyl methacrylate, 2-diethylamino ethyl acrylate and the like. These copolymers preferably contain a predominant amount of polymerized ethylene and more preferably greater than 60 percent by weight polymerized ethylene.

The ethylene/mono-unsaturated ester copolymers used in the practice of this invention, preferably have a melt index measured at 44 p.s.i. and 190° C. greater than 100 dgm./min. and more preferably a melt index between about 100 and 400 dgm./min. Lower melt index copolymers may be used, however, where the lower alkene polymer has a high melt index.

The wax component having a melting point of from about 75 to about 95° C. may be a naturally occurring or a synthetic wax and is preferably a microcrystalline wax.

The function and relationship of the components of the bonding agent of this invention are of considerable importance.

The lower alkene polymer acts as the base of the bonding agent composition and is present in an amount of from about 70 to about 90 percent by weight based on the total weight of the resinous bonding agent composition, preferably from about 70 to about 85 percent by weight.

As a component of the bonding agent composition, the ethylene copolymer appears to serve important wetting and adhesive functions. The bonding agent must bind substantially all the fibers of a strand together at the back of the tufted web to assure a low incidence of pilling.

The presence of the high melt index ethylene copolymers in the bonding agent composition of this invention appear to promote fiber wetting and thereby enhance complete fiber bundle penetration. The copolymers also enjoy an adhesive function as an affinity intermediary between the relatively non-polar lower alkene polymer base and more polar continuous filaments such as nylon, polyesters, acrylics, modacrylics and the like.

The wax component of the bonding agent composition of this invention appears to act as a penetrant or lubricant to promote flow of the bonding agent composition into the porous bundle. While essentially required for low melt index hydrocarbon polymer and lower alkene polymer, a lower limit for the wax can be avoided where the fibrous strand has a low cross-sectional fiber density and where both the hydrocarbon polymer of a lower alkene and the ethylene copolymer have proportionally high melt indices. It has been found, however, that when present the wax must fit into the scribed melting range to provide utility to wool and rugs, since it has been found that waxes of a lower melting point appear to cause excess penetration and introduce boardiness and brittleness to the rug or carpet due to...
"strike-through" of the backing and waxes of higher melting point fail to improve the penetrability and cause brittleness in the end product.

When present, the amount of wax also appears to be important. While wax concentrations of from about 20 to about 10 percent by weight based on the total weight of the resin bonding agent are universally useful and wax concentrations up to about 15 percent by weight are utilized, concentrations above this upper limit tend to show excessive penetration and "strike-through" of the backing causing the rug or carpet to become stiff or "boardy."

The bonding agent compositions of this invention may be readily prepared by conventional methods such as hot compounding techniques and can be applied to the back of a tufted web as a particulate dry powder, a melt or in a solvent solution. Application as a particulate dry powder is particularly preferred when the resin bonding agent composition is used in conjunction with the aforementioned process of this invention.

The bonding agents of this invention display a good tolerance for fillers. Fillers may be added in an amount up to about 33 parts by weight for each 100 parts by weight bonding agent and include amongst others, barium sulfate and calcium carbonate based fillers with barium sulfate based fillers preferred. The fillers should have a particle size below about 60 microns and preferably below about 40 microns.

In addition to fillers, dyes, pigments, preservatives, opacifiers, extenders and the like may be incorporated to the bonding agent compositions of this invention.

While the bonding agents of this invention show particular utility in constructing tufted rugs and carpets from fibrous strands of continuous filament synthetic fibers, it will be appreciated that the bonding agents may also be used in construction of tufted rugs and carpets from all natural and synthetic fibers including amongst others wool, rayon, cotton, nylon, the acrylics, modacrylics, the polyolefins and the like. In addition, the bonding agents may be used to provide additional backing and body to conventional woven and nonwoven rugs and carpets.

While the novel bonding agent composition of this invention is particularly useful in the practice of the process of this invention, it must be appreciated that other bonding agents may also be used so long as the steps of singeing and pre-heating are incorporated to achieve the good fiber bundle penetration and reduction is bonding agent composition heating time.

Methods used for determining the properties of resins evaluated in the following examples were:

<table>
<thead>
<tr>
<th>Density</th>
<th>Resin A—polyethylene homopolymer having a melt index of between 18 and 25 and a density about 0.916 and 0.920.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melt index</td>
<td>Resin B—polyethylene homopolymer having a melt index between 50 and 100 and a density between about 0.916 and 0.920.</td>
</tr>
<tr>
<td></td>
<td>Resin C—an ethylene-acrylic acid copolymer containing about 15% by weight combined acrylic acid and having a melt index of about 90.</td>
</tr>
<tr>
<td></td>
<td>Resin D—an ethylene-ethyl acrylate copolymer containing about 25% by weight combined ethyl acrylate and having a melt index of about 20.</td>
</tr>
<tr>
<td></td>
<td>Resin E—an ethylene-vinyl acetate copolymer containing about 28% by weight combined vinyl acetate and having a melt index between about 250 and 350.</td>
</tr>
</tbody>
</table>

Mixtures of the resins employed in the studies were obtained by dry blending in a high speed stirrer. The mixtures were applied in powder form to the back of a nylon 4" x 4" tufted web sample until an even coating having a weight of 12 ounces per square yard of tufted backing was obtained. The powdered resin mixtures were then exposed to a heat zone of 10 infrared lamps having a power of 375 watts per lamp at a distance of six inches from the back of the tufted web back for a period of three minutes. The sample was then removed from the heat zone, and the fluid bonding agent candidate smoothed over the back with a hand roll, the coated carpet sample was then allowed to cool for 24 hours and tested for the degree of fibrous strand penetration, and in some instances tuft lock.

Fibrous strand penetration was determined by cutting a section of the bonded portion of the tufted carpet in the tuft direction and observing the cut section under a microscope having a magnification of 45 X. The degree of penetration of the adhesive coating resin mixture into the fiber bundles was objectively determined and expressed as percentage penetration.

The test for tuft lock was made by selecting loops of the bonded tufts for testing and then cutting the tufted loops in the tuft direction. A weight scale was then inserted into the test loop and pulled until the loop broke away from the backing and the pounds of force required to break the test loop measured. The average of five separate tests for each resin coating mixture was taken and reported as tuft lock in pounds.

The results of testing samples of nylon tufted carpets for fiber bundle penetration and tuft lock after being treated with various bonding agent mixtures are set forth in Table I below wherein the amount of lower alkene polymer and ethylene copolymer resins present in the bonding agent are expressed as percent by weight.

### TABLE I

<table>
<thead>
<tr>
<th>Example</th>
<th>Resin:</th>
<th>Resin in bonding agent mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>D</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>E</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Density</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melt index</td>
<td>70</td>
</tr>
</tbody>
</table>

Examples 1–16

Since tufted carpets and rugs constructed from strong, continuous nylon filaments exhibit a great tendency to pill, nylon tufted webs were used in evaluating several synthetic resin compositions to determine which would show good fiber bundle penetration and therefore introduce effective pilling resistance to the tufted web. The combinable resins selected for the study were as follows:

From this information, several factors become evident. It was clear that a broad mixture of resins was not the solution to the problem of obtaining good fiber bundle penetration.

When considering the ethylene copolymers, the nature of the comonomer appeared important. While the medium polarity copolymers such as ethylene-ethyl acrylate and
ethylene-vinyl acetate copolymers enhanced fiber bundle penetration, the more polar ethylene-acrylic acid copolymer appeared to retard penetration despite its high melt index. Melt index, however, did prove important since significant improvements in penetration were not observed until the melt index of the ethylene copolymer rose about 100 dgpm/min. When considering the base polyethylenes, again an increase in melt index increased fiber bundle penetration.

As to copolymer concentration, it appeared that tuft penetration increased up to about 20 percent concentration but then began to taper off at concentrations above this level. It seemed, therefore, prudent to limit copolymer concentration to an upper level of about 30 percent.

Examples 17–39

In a next series of studies the possibilities of incorporating a wax into the base resin blends to improve fibrous tuft penetration was taken into consideration. Several classes of waxes were studied to determine wax properties required to improve fiber bundle penetration.

To provide a fair relative basis for comparison, two resin blends were selected for the study. The first was a resin blend comprising about 80 percent by weight resin A and about 20 percent by weight resin E. The second was a resin blend comprising about 80 percent by weight resin B and about 20 percent by weight resin E. These blends allowed a study of wax influence on blends containing low and high melt index lower alkene at constant copolymer concentration.

The blends of lower olefin polymer and copolymer resins were prepared in the same manner as is described above. To these resin mixtures there was normally added about 5 percent by weight of the candidate waxes by dry blending until a homogeneous mixture was obtained. In some instances, higher wax concentrations were tried. Each powdery mixture was then applied to the back of tufted carpets in the same manner described above and the carpet samples tested for bulk fiber penetration and tuft lock as set forth hereinafter. The results obtained are shown in Table II.

The data made evident that even a small amount of a properly selected wax could improve fiber penetration and increased the penetrability of resin blends containing low melt index lower olefin polymers to equal the penetrability of resin blends containing higher melt index lower olefin polymers without a wax. It further established that the wax would aid the penetrability of higher melt index base resins.

Petroleum-based microcrystalline waxes having melting points of from about 75 to 95°C proved to perform most satisfactorily. The lower melting waxes generally caused the bonding agent to become brittle and the rug sample to become stiff or boardy due to excessive flow of the bonding agent wax blend through the tufted backing. The high melting waxes also generally caused the bonding agent to become brittle.

While the microcrystalline waxes seemed to perform best, this did not appear to preclude the possible use of other types of waxes so long as this melting point range was met. Unfortunately, the number of commercial waxes in this melting point range proved somewhat limited to the microcrystalline waxes.

As to the amount of wax incorporated into the resin blend, the addition of more than about 10% to a resin blend containing a high melt index lower olefin polymer so greatly increased fluidity that the bonding agent excessively penetrated the backing causing the rug sample to become boardy.

While higher wax concentrations could be tolerated in resin blends containing lower melt index lower olefin polymers boardiness was again seen to set in at a wax content above about 15 percent by weight based on the total weight of the bonding agent.
Example 40

To establish the effect of singeing the back of a tufted web to remove fiber fuzz prior to application of the bonding agent, a hot air gun, a gas burner and infrared lamps were first evaluated as possible singeing means. In a pre-bonding agent deposition test it was shown that while the hot air gun and Bunsen burner singed off fiber fuzz without deleteriously fusing the fiber bundle, the infrared lamps were found to fuse a portion of the fiber bundle before fiber fuzz was effectively singed off.

To remove fiber fuzz with a hot air gun, the gun was set at the "hot" setting and positioned over the back surface of the tufted roll at height of about 2 inches and held there for a period of about 10 seconds. The temperature at the nozzle of the hot air gun when set at "hot" was about 230° C.

At this time exposure it was found that fiber fuzz was almost completely removed with only a negligible amount of fusion of the nylon fiber bundle. When the gun was applied for 15 seconds under the same conditions, it was found that, in addition to singeing off the fiber fuzz, a substantial portion of the nylon fibers were fused.

The degree to which fiber bundle penetration could be increased by removing fiber fuzz from the back of nylon tufted carpet samples was studied using the 10 second hot air gun treatment described hereinabove, prior to pre-heating the carpet and applying the bonding agent. The penetrations obtained for a variety of compositions were compared to the fiber bundle penetration obtained when no fiber fuzz were removed. It was found that fiber bundle penetration increased in an amount of between about 15–35% depending upon the composition employed. The results of these tests are set forth in Table III.

### Table III

<table>
<thead>
<tr>
<th>Bonding agent composition</th>
<th>Exposure to hot air gun (seconds)</th>
<th>Percent fiber bundle penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Resin A</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>100% Resin B</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>90% Resin B</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>80% Resin B</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>70% Resin E</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>60% Resin E</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>50% Resin E</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>40% Resin B</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>30% Resin E</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>20% Resin E</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>10% Resin E</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>5% wax</td>
<td>10</td>
<td>50</td>
</tr>
</tbody>
</table>

1. A microcrystalline wax having a melting point of 82-88° C.

In lieu of the hot air gun, a Bunsen burner was employed to singe off fiber fuzz by playing the flame on the back of the carpet for a period of between about 15–20 seconds at a distance of between about 3–5 inches. Results were comparable to that obtained when the hot air gun was used.

Example 41

Using apparatus corresponding to that shown in the Drawing, studies were made to determine the effect of pre-heating on fiber bundle penetration.

For each study, a standard consisting of a powdered bonding agent comprising 80 percent by weight of resin A and 20 percent by weight resin D was applied to 4" x 4" sections of a nylon tufted carpet until a coating weight of 12 ounces per square yard was obtained. Prior to application of the bonding agent, the carpet sections were preheated in a unit consisting of a bundle of 10 infrared lamps each having a power of 375 watts which were used to heat carpet surface until it was warm to the touch; namely at a temperature of between about 40–60° C. After the bonding agent was applied, the coated carpet sections were again heated under 10 infrared lamps of the same power until the bonding agent melted and penetrated the web. The fiber bundle penetrations obtained as well as the effect of pre-heat on time required to cause fiber penetration are set forth in Table IV.

### Table IV

<table>
<thead>
<tr>
<th>Percent fiber bundle penetration</th>
<th>Time required to achieve fiber strand penetration, seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-heat time, min.</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>30</td>
</tr>
<tr>
<td>1.5</td>
<td>40</td>
</tr>
<tr>
<td>2.0</td>
<td>60</td>
</tr>
<tr>
<td>2.5</td>
<td>50</td>
</tr>
<tr>
<td>3.0</td>
<td>60</td>
</tr>
<tr>
<td>3.5</td>
<td>55</td>
</tr>
<tr>
<td>4.0</td>
<td>55</td>
</tr>
<tr>
<td>4.5</td>
<td>60</td>
</tr>
<tr>
<td>5.0</td>
<td>60</td>
</tr>
</tbody>
</table>

1. Carpet starts to brown.
2. Carpet turns brown.

As can be seen, good fiber bundle penetration was obtained when the coated carpet was pre-heated for a period of between about 2–4 minutes without deleteriously affecting the resulting carpet and that pre-heating significantly reduced fiber penetration time.

It is believed that the good penetration results obtained by pre-heating the carpet prior to applying the adhesive coating properly result from the reduced tendency of the tufted carpet to act as a heat sink thereby resisting the temperature increase of the bonding agent at the surface of the tufted web.

Examples 42

In order to provide added body to carpets, various commercially available filler materials were added to the bonding agent of the present invention. Among the filler materials tested were a barium sulfate-based filler consisting of about 98 percent by weight of powdered barium sulfate and having a particle size of about 3–40 microns and a specific gravity of about 4.4, a barium sulfate-based filler consisting of about 94 percent by weight of powdered barium sulfate and having a particle size of between about 55–75 microns and a specific gravity of about 4.3, and a calcium carbonate-based filler consisting of about 98 percent by weight of powdered calcium carbonate and having a particle size of about 0.3–14 microns and a specific gravity of about 2.71. These fillers were incorporated into the bonding agent compositions of the present invention in amounts ranging from between about 5–25 percent by weight based upon the total weight of the composition. At these filler concentrations, good results were obtained with both of the barium sulfate-based fillers, the barium sulfate-based filler having the smaller particle size exhibiting slightly better characteristics than the one having the larger particle size. Use of the calcium carbonate-based filler, while operable, required an increase in time to fuse the adhesive coating composition and resulted in tufted carpets exhibiting unsatisfactory brittleness.

Example 43

Various commercially available surfactants were also employed to determine if the properties of tuft lock, pill resistance and fiber bundle penetration could be improved. The surfactants tested included an anionic surfactant comprising a solution of 25 percent by weight sodium lauryl sulfate in water, a nonionic surfactant consisting of the reaction product of a nonylphenol and ethylene oxide, and a cationic surfactant comprising a suspension of oleic imidazoline (91% active) and unreacted linear cationic surfactants; these surfactants were blended into the bonding agent compositions in amounts ranging from between about 0.2–0.5 percent by weight based on the total weight of the adhesive coating composition. Tests were conducted under similar control conditions as described hereinabove with regard to the fillers wherein tufted carpets were first pre-heated and then not pre-heated, the fuzzy fibers were first removed by singeing and then were not removed, and fillers were first incorporated in the coating composition and then were
omitted. The results obtained revealed that the anionic surfactant employed improved pilling resistance while exhibiting no deleterious effect on tuft lock or fibrous strand penetration. The nonionic surfactant had no affect on the properties tested while use of the cationic surfactant resulted in poorer pilling resistance.

Example 44

The combined effect of singeing and pre-heating were evaluated on a continuous web coating unit which substantially conformed to the unit schematically shown in the attached drawings. This unit was provided with an open gas flame singeing zone, a 14.4 kw. radiant pre-heating zone and a 43.2 kw. radiant heating zone each heating zone operated at up to 55% of capacity. The apparatus was used in coating a 12 inch wide nylon tufted web at a rate of 5 feet per minute.

Three bonding agent systems were studied.

Bonding Agent I constituted a blend of 72.7 percent by weight Resin B, 18.2 percent by weight Resin E and 9.1 percent by weight of microcrystalline wax having a melting point of 188°F.

Bonding Agent II constituted a blend of 76.3 percent by weight Resin B, 19.0 percent by weight Resin F and 1.9 percent by weight of a microcrystalline wax having a melting point of 86–87°C.

Bonding Agent III constituted a blend of 100 parts by weight Bonding Agent II and 25 parts by weight of No. 1 Bleached Barytes.

The operating conditions employed and results obtained are listed in Table V.

<table>
<thead>
<tr>
<th>Machine conditions:</th>
<th>I</th>
<th>I</th>
<th>I</th>
<th>I</th>
<th>II</th>
<th>II</th>
<th>III</th>
<th>III</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singeing</td>
<td>No Yes</td>
<td>No Yes</td>
<td>No Yes</td>
<td>Yes No</td>
<td>No Yes</td>
<td>No Yes</td>
<td>No Yes</td>
<td>No Yes</td>
<td>No Yes</td>
</tr>
<tr>
<td>Pre-heating, percent capacity</td>
<td>65 65 65 65 65 65 65 65 65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In. above web</td>
<td>No Yes Yes</td>
<td>6.5 6.5 6.5 6.5 6.5 6.5 6.5 6.5 6.5</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Main heating, percent capacity</td>
<td>No Yes Yes</td>
<td>10 10 10 10 10 10 10 10 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In. above web</td>
<td>No Yes Yes</td>
<td>10 10 10 10 10 10 10 10 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nip roll pressure, psi</td>
<td>No Yes Yes</td>
<td>25 25 25 25 25 25 25 25 25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary backside</td>
<td>10 10 10 10 10 10 10 10 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of coater, lb/yd</td>
<td>No Yes Yes</td>
<td>100 100 100 100 100 100 100 100 100</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Tuft lock, lbs</td>
<td>24 24 24 24 24 24 24 24 24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Although the bond agent compositions universally gave about 100% fibrous strand penetration, adding the singeing step actually improved overall pilling resistance. The reduction in tuft lock when a secondary backside was used was attributed to allocation of the available bonding agent to bond the scrim to the web. Note, however, that the presence of a secondary scrim did not affect fibrous strand penetration.

When independently evaluated using subjective but industry accepted pilling rating tests, tufted nylon carpet and rug samples produced using the method and compositions of the invention were rated from good to excellent.

A carpet or rug having a good rating is considered to be merchantable.

What is claimed is:

1. A resinous bonding agent which comprises, based on the total weight of the resin from

(a) about 70 to about 90 percent by weight of an ethylene hydrocarbon polymer having a melt index measured at 190°C, of less than about 0.15 dgm./min, which polymer is composed of lower-alkene,
(b) about 10 to about 30 percent by weight of an ethylene/monounsaturated ester copolymer having a melt index measured at 44 p.s.i. and 190°C, of less than about 0.15 dgm./min, which copolymer contains greater than 60% by weight polymerized ethylene, ethylene/ethyl acrylate copolymers having a melt index of from about 100 to about 400 dgm./min, measured at 190°C, and 44 p.s.i.

2. A bonding agent as claimed in claim 1 in which the ethylene hydrocarbon polymer has a melt index measured at 190°C and 44 p.s.i. of from about 70 to about 95°C.

3. A bonding agent as claimed in claim 12 in which the hydrocarbon polymer is polyethylene.

4. A bonding agent as claimed in claim 1 in which the ethylene/monounsaturated ester copolymer is selected from the group consisting of ethylene/vinyl acetate and ethylene/ethyl acrylate copolymers containing a major proportion by weight polymerized ethylene.

5. A bonding agent as claimed in claim 1 in which the ethylene/monounsaturated ester copolymer has a melt index measured at 190°C and 44 p.s.i. of from about 100 to about 400 dgm./min.

6. A bonding agent composition as claimed in claim 1 in which the filler is present in an amount up to 33 parts by weight per 100 parts by weight resin.

7. A bonding agent as claimed in claim 6 in which the filler is barium sulfate or calcium carbonate.

8. A resinous bonding agent comprising, based on the total weight of the resins from

(a) about 75 to about 85 percent by weight of an ethylene homopolymer having a melt index of from about 50 to about 100 dgm./min. measured at 190°C.

(b) about 15 to about 25 percent by weight of an ethylene/monounsaturated ester copolymer selected from the group consisting of ethylene/vinyl acetate and ethylene/ethyl acrylate copolymers having a melt index of from about 100 to about 400 dgm./min.

9. A resinous bonding agent as claimed in claim 8 in which a filler is present in an amount up to 33 parts by weight per 100 parts by weight resinos bonding agent.

10. A resinous bonding agent as claimed in claim 9 in which the filler is barium sulfate or calcium carbonate.

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MORRIS LIEBMAN, Primary Examiner
P. R. MICHL, Assistant Examiner

U.S. Cl. X. R.

117—138.8 A; 161—66; 260—28.5 AV, 41 R, 897 B
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,645,949 Dated February 29, 1972
Inventor(s) Fred J. Crimi

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

Column 2, line 33, "tilted" should read -- tufted --;
line 35, insert -- the -- after "below"; line 48, "fiber",
second occurrence, should read -- fibers --. Column 4, line 13,
after "ene" insert -- propylene --. Column 8, line 11, under
"Example 35, relative to "Tuft lock, 1bs.", "21.1" should read
-- 21.2 --. Column 9, line 10, "signed" should read -- singed --
Column 10, line 28, "Examples" should read -- Example --.
Column 11, line 23, insert -- by -- after "percent". Column 12,
line 7, in claim 3, "claim 12" should read -- claim 2 --.

Signed and sealed this 7th day of January 1975.

(Seal)
Attest:

McCOY M. GIBSON JR. C. MARSHALL DANN
Attesting Officer Commissioner of Patents