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(54) THE PRODUCTION OF PILE-SURFACED PRODUCTS

- (71) We, IMPERIAL CHEMICAL INDUSTRIES LIMITED of Imperial Chemical House, Millbank, London SW1, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
This invention relates to a process for the production of pile-surfaced products and to products produced thereby. Attention is drawn to our copending Divisional Applications 21307/74 and 21311/74 (Serial Nos. 1,378,639 and 1,378,640).
The invention provides a process for the production of a pile surfaced product which comprises the steps of interposing a softened or heat softenable filament forming composition between a foundation layer and a heated roll having a smooth or roughened surface holding the foundation layer against the softened composition so that bonding of the composition surface of the foundation layer and adhesion of the composition to the heated roll occurs, parting the composition from the heated roll so that filaments or tufts of the softened composition are formed between the foundation layer and the heated roll, hardening the filaments or tufts so formed by a

stream of cooling fluid and separating them from the heated roll. 30

Filament forming thermoplastic polymeric compositions which may be employed in the process of the invention include addition polymers, for example polymers and copolymers of ethylene, propylene, butadiene, vinyl chloride, vinyl acetate, vinylidene chloride, acrylonitrile and styrene and condensation polymers, for example polyamides and polyesters, e.g. of glycols and aromatic dicarboxylic acids. Blends of filament forming polymeric compositions may be used. 35 40

As specific examples of thermoplastic polymeric compositions that can be employed in the process of the invention we may mention polyethylene, polypropylene, nylon, polyethylene terephthalate and polyvinyl chloride. Such thermoplastic polymeric compositions are preferably used in the form of a sheet; such may be, for example, a continuous film or a perforated web. The thickness of the sheet of polymeric composition is not critical although it will be recognised that generally the use of thicker sheets will yield heavier duty and more expensive products while the thinner ones will be lighter, cheaper and more flexible. 45 50 55

Other thermoplastic compositions which

[Price 25p]

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may be employed according to the invention include glasses, particularly low melting inorganic oxide glasses, and the term filament forming composition as used herein may be understood to include these, unless otherwise specified.

If desired the product may be coloured, either generally, or locally as in patterned or lettered products, for example, by employing a coloured filament forming composition, an appropriately printed monolayer, a multilayer polymeric sheet (one or more of the layers being appropriately pigmented) or by local application of an appropriate colouring agent.

For use in the process of the invention, the filament forming composition may be softened in any suitable manner such as by heat and/or the action of plasticizers (e.g. as in vinyl plastisols) or solvents. For example, in the case of heat-sensitive polymers such as polyvinyl chloride, the polymer may be mixed with a non-polymeric compound, or a mixture of non-polymeric compounds, which is solid at ambient temperatures and in which the polymer dissolves at elevated temperatures. Such a mixture will have softening properties different from those of the polymer itself, some further control of the process conditions being possible as a consequence.

Where the softening is to be effected partly or wholly by heat, which is the preferred agency, at least some of the heat may be supplied to the filament forming composition for example through contact with the heated roll and/or the foundation layer. However, because of the problems of heat transfer that are involved particularly when a relatively thick layer of the filament forming composition is employed, or at high production rates, it may be preferred that at least some of the heat is supplied to the filament forming composition by preheating. In one embodiment, for example, the composition may be supplied hot, e.g. in sheet form by melt extrusion. Alternatively, it may be supplied e.g. from a roll of film and preheated. In yet a further alternative, the filament forming composition may be applied to the surface of the foundation layer or to the heated roll e.g. in powder or granule form and then converted to a continuous or discontinuous layer by heating and rolling prior to, or possibly even simultaneously with, treatment by the process of the invention. In yet another alternative, it may be supplied in the form of a woven textile. In a further alternative, the composition may be supplied in cellular or foamed form. The foamed or cellular composition may be supplied in the form of a freshly extruded sheet or may be preformed and then softened, e.g. by heat. Again, the filament forming composition may be cast on to the heated roll from an extruder.

The foundation layer may be of any suitable material. Thus it may be of a natural

or synthetic material. As an example of a natural material we may mention regenerated cellulose (e.g. "Cellophane" (Registered Trade Mark)). Synthetic materials from which the layer may be made include for example those described above as being suitable for use as the filament forming compositions. It is, of course, essential for bonding of the filament forming composition and the foundation layer to occur, at least sufficiently to prevent their separation when separation of the filaments from the heated roll occurs, and while sufficient bonding may come about without any particular pretreatment of the foundation layer some treatment of its surface may be advantageous, e.g. an appropriate softening agent or solvent may be applied whereby the surface of the foundation layer is softened without bringing about disintegration or undesirable disruption of the layer. Suitably the softening agent or solvent is evaporated from the composite product by the heat of the heated roll. Selection of the foundation layer and filament forming composition which bond together easily under the conditions employed in the process of the invention is desirable. Very smooth surfaced foundation layers are generally less easy to bond than those having a rough, pitted or uneven surface, and a pretreatment to reduce the smoothness of the surface, e.g. by abrasion, can be advantageous.

Examples of porous or perforated foundation layers are woven and unwoven textile webs, which may be of any desired material including metal (although where a synthetic material is used as the foundation layer it may be preferred that it is not softened by the conditions to which it is exposed during the process). It is often convenient to use a woven textile as the layer. For example, we have obtained satisfactory results with hessian, cotton net, glass fibre scrim, linen scrim and the like. The layer may also be of paper or other material, e.g. metal, cardboard or paper having holes formed e.g. punched, in it. It may also be of expanded metal, expanded plastics, or extruded plastics net. Plastics foam sheeting e.g. of polyurethane has been pile surfaced using the process of the invention particularly open-celled relatively thin (e.g. 1—5 mm thick) foam although much thicker foams may be treated also. Bonded, unwoven or unbonded, unwoven layers can be used. Bonding of an unbonded, unwoven layer during the process of the invention may occur by means of a bonding agent, which may be for example a thermosetting polymer, or even by means of the filament forming composition itself, although care may be needed in pull-off, until the bonding agent has hardened sufficiently to maintain the integrity of the product.

For convenience hereinafter, the word "web" will be used, unless otherwise specified, to refer to all forms of foundation layer

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i.e. to continuous sheet surfaces as well as to porous or perforated webs described above.

The filament forming composition may be contacted with the layer prior to or after contacting the heated roll, or simultaneously therewith as desired and as is convenient. The filament forming composition may be supplied in a form other than a homogeneous sheet. For example, it may be supplied in the form of an external layer of a laminate; one outer layer of the laminate may comprise a filament forming thermoplastic polymeric material while another layer may be, for example, of wear resistant material, e.g. filled plastics or fabric-reinforced plastics. Thus a previously formed laminate (in which the laminae may or may not be bonded together) of the web and a web, sheet or film of the filament forming composition may be contacted with the heated roll. Alternatively, the web and the filament forming composition may be offered, separately to the heated roll.

The use of a resilient means to hold the web and the softened filament forming composition against the heated roll tends to give a product having a well-bonded pile. Therefore according to one embodiment of the present invention the web is held against the softened filament forming composition by resilient means. For example, the foundation layer and the filament forming composition may be held and preferably pressed together with the filament forming material in contact with the heated roll by a resilient roller or any other suitable pressure-applying means which is preferably at a temperature and/or has surface properties such that the web will not stick to it. (Note that "pressure-applying means" as used herein covers means simply for holding the web and filament forming composition in contact with the heated roll).

By "resilient" in the context of this specification we mean that the pressure-applying surface is not hard and unyielding as is the case, for example, if a steel or ceramic surface pressure roll is employed. Materials having a wide range of resilience or hardness may be employed e.g. up to a Shore hardness of 20, 40 or even 70 as measured on a Shore Durometer Type AS (ASTN D676). A minimum hardness is one consistent with the ability to hold the web against the filament forming composition and the heated roll sufficiently for the performance of the invention. The resilient material preferably is one having a minimum value of 8 being the load in pounds required to produce an indentation of 0.25 inch in a sheet of the material 1" thick when the material is placed between two square plates each 50 sq. in. in area (see ATSM D1564/64T). We have found that a minimum thickness of resilient material of about 1 mm, preferably 2—6 mm is desirable, although the thickness may be increased, with advantage, particularly when harder resilient

materials are employed. Examples of resilient materials, which in use should be chosen with regard to their ability to withstand the operating conditions, particularly high temperature and repeated compression include silicone rubbers, neoprene rubbers and polyurethane foams. Open or closed cell foams may be used. As examples of natural resilient material we may mention cork and rubber.

The operating conditions of the process of the invention are chosen so that the softened filament forming composition adheres both to the heated roll and to the web and, when the web and the filament forming composition are parted from the heated roll, filaments or tufts of the composition are formed. These filaments or tufts are then hardened by cooling so that as the web/heated roll distance is progressively increased the filaments part from the heated roll to form a hardened fibrous or tufted pile on the web. The control of the degree of cooling is important because if the filaments or tufts are insufficiently cooled they tend to retract back on parting from the heated roll.

The length and form of the filaments or tufts forming the pile is influenced by the rate at which they are hardened, the temperature of the hot roll and the rate of parting of the web and filament forming composition and the roll. The mechanical properties of the filaments or tufts will be influenced by the nature of the filament forming composition and the degree to which the filaments or tufts are stretched during the process. Thus, by varying the choice of filament forming composition or web and of the conditions operating during the process, products having a wide range of properties, texture and appearance may be obtained. We prefer to cool the filaments or tufts as they are drawn, by directing upon them a stream of cooling gas, e.g. air, or where axial oxidation is likely to prove troublesome, an inert gas, for example nitrogen.

The nature of the finish depends largely upon the temperature of the drawn filament forming composition at the point in time at which it is separated from the heated roll. Thus the degree of retraction of the filament forming composition, is influenced by its temperature at this point. This will, of course, be influenced by the temperature of the heated roll and the temperature, flow rate and direction of the cooling fluid employed. The flow of coolant may be varied across the width of the product and/or with time, an increase in flow rate tending to reduce the length of the filaments and vice versa; the distance between the point at which the tufts or the like are produced and the coolant supply means may be varied across the width of the product and/or with time. For example, variation of this distance may be used to alter the nature of the filaments or tufts, in particular their

curliness; the temperature of the coolant (especially at the point of fibre production) may be varied across the width of the product and/or with time; and the coolant supply means may take the form of a series of orifices or a slit extending across the width of the product. The effect produced by any of these variables may be modified by such factors as the directional arrangement of the slit or orifices and their distance from the point of fibre production, but, in general, a series of orifices can if desired, be used to produce products having regular variations of height of pile across the width of the product.

For many purposes it is preferable to select a particular combination of coolant and other parameters and then run the process until stable product properties are obtained. It will be appreciated, of course, that any of the parameters may be varied in a cyclical manner to produce patterned or other non-uniform effects.

The rate of pull-off, and the tension, of the product can also influence the nature of the surface texture of the product.

The process is preferably employed in a "continuous" fashion so that extended production runs can be accomplished. Thus, if a backing means is used to hold the web against the filament forming composition and the composition against the heated roll this backing means which is optionally resilient may be, for example, a conventional pressure roll which may be surfaced with a resilient material, for example, a foam or rubber material having the desired resilience characteristics, and this is the preferred system. However, it is apparent that any endless surface may be employed as the backing means and we may employ a roller or endless belt which in combination with the heated roll, forms a nip to which the filament forming composition and the web may be supplied continuously and from which the product may be withdrawn continuously. It will be appreciated that a roll or belt having a resilient surface includes rolls and belts made substantially or wholly of resilient material, although these may not be preferred.

The duration of contact of the filament forming composition with the hot roll will depend upon the path length between the point at which the filament forming material contacts the roll surface and the point at which it leaves it, and the speed of rotation of the roller, which conveniently is driven at a speed related to the take-up speed of the product roll.

It may be desired to modify or prevent production of a pile surface in predetermined areas of the product to give a patterned effect. This may be achieved for example by rendering part of the surface of the heated roll non-adhesive to the filament forming com-

position, e.g. by applying a coating to the said surface to which the filament forming composition does not adhere under the operating conditions employed. As an example, where the filament forming composition is polyethylene, selected areas of the roll surface may be provided with a coating of polyethylene wax, which may easily be removed after use. Again, the surface of the heated roll may be embossed such that some parts are recessed to adjacent parts so that the filament forming composition fails to contact the recessed parts. An alternative method is to interpose a suitable stencil between the filament forming composition and the heated roll. Such a stencil, of course, would be one to which the filament forming composition does not adhere to a degree sufficient to produce a pile surface on the eventual product.

We have found that it may be advantageous to cool the filament forming composition to harden the filaments as the composite product emerges from the nip by cooling the web from the side away from the heated roll either in addition, or as an alternative to the cooling by direct impingement of coolant upon the fibrils. In this way cooling of the filaments or tufts is accelerated by cooling the side of the web distant from the heated roll and cooling may occur after the filaments have been drawn and before they separate from the heated roll.

The cooling means employed is, a stream of fluid, preferably gas, especially air or nitrogen, at a temperature below that of the web additional cooling may be provided by a cooled roller, rod or tube with which the web makes surface contact, and preferably is slightly tensioned around or which provides a local cold environment which is effectively a heat sink. When a fluid is to be employed as the cooling means we have found compressed air, at ambient temperature or lower and at a pressure between 10 lb/sq. in. and 60 lb/sq. in. particularly between 20 and 30 lb/sq. in. to be suitable. As an example of a cooling means of tubular form we may mention a tube suitably of a highly heat conductive material, e.g. copper or other metal, through which flows a stream of cooling fluid, which may be a liquid, for example water or a liquefied gas, or gas. The temperature of the cooling fluid is chosen to bring about the desired degree of cooling of the web, having regard to the materials being employed thickness of the web, rate of throughput of the web, etc.

According to yet a further aspect of the invention the web itself is employed to hold the filament forming composition to the heated roll. This may be accomplished by applying sufficient tension to the web to urge it against the filament forming material without undesirably disrupting the web. This last necessity will be apparent unless a supple-

mentary backing or supporting layer, suitably tensioned is employed.

This aspect of the invention facilitates cooling of the surface of the web distant from the heated roll ("back cooling") since an additional cooling means such as a tube or rod may be disposed across the width of the web, and preferably at right angles to its direction of travel, around which the web is pulled to effect its removal from the heated surface at a relatively sharp angle—preferably between about 30 and 80°, more preferably between 50 and 75° to the tangent to the surface of the heated roll at the point where it leaves the roll. Back cooling is facilitated by use of this aspect of the invention, but cooling by direct impingement of cooling fluid on the fibres by directing a stream of cooling fluid into the existing nip is the preferred method. Direct impingement of cooling fluid together with back cooling is a particularly appropriate combination.

In all previously described aspects of this invention cooling preferably occurs for a period sufficiently long before parting of the filaments or tufts from the heated roll to prevent their complete relaxation with consequent loss of the pile surface effect. The temperature of the cooling means, or combination thereof, will be influenced by the reduction in temperature of the product which it is desired to effect, having regard to the materials employed and the temperature of the heated roll, the thickness of the web and filament forming composition, rate of travel of the web etc.

A further aspect of the invention provides a process, which is related in addition to British Patent Specification 1,334,672 and which comprises pressing the softened filament forming composition through a porous or perforated web by means of a resilient pressure means as hereinbefore described situated behind the web into contact with the heated roll and separating the porous or perforated web from the filament forming composition after the filaments or tufts have hardened and after separation from the heated roll.

For convenience the porous or perforated web will be referred to hereinafter as the perforated web.

A degree of control of the density of the fibrous or tufted surface is provided by use of the perforated web since the number of filaments or tufts formed per unit area may be controlled by the number of pores or perforations per unit area of the web. The use of a relatively thin sheet of the filament forming composition may be advantageous in that, as will be described later, the product may itself be porous.

The perforated web may be of any suitable material, although consideration has to

be taken of the necessity for eventual separation of the web and filament forming composition and consequently a perforated web is used of material which either in itself or as a result of application of an appropriate parting material is easily released from the filament forming composition. Examples are woven and unwoven textile webs, including metal, although where a synthetic material is used it is preferred that it is not softened by the conditions to which it is exposed during the process. For close control of the texture of the pile formed by the process, it is generally preferable to use a woven textile, and when the perforated web is recycled repeatedly adequate strength is obviously an essential although for "one off" use it is not necessary to use particularly high strength material. For example, we have obtained satisfactory result with hessian, cotton net, glass fibre scrim, linen scrim, nylon and "Terylene" (Registered Trade Mark) nets and the like. If the perforated web has too close a weave it may prove difficult to press the filament forming composition through it unless the filament forming composition has a low viscosity in the softened or molten state, and the subsequent separation may also be difficult. The perforated web may also be of paper (although this may be weak and therefore is not preferred) or other material, e.g. metal or cardboard, having holes formed, e.g. punched, in it through which the thermoplastic filament forming composition may be pushed during the process. It may also be expanded metal or expanded plastics, or extruded plastics net. Parting materials with which the perforated web may be treated include silicones, and other non-stick agents, e.g. polytetrafluoroethylene although these may not be necessary when the material of the web is of low inherent adhesion e.g. a monofilament material. Parting agents are particularly useful when "rough" perforated web materials, e.g. hessian, cotton and the like are employed.

It will also be appreciated that different surface effects may be produced by varying the nature, e.g. size, number and arrangement, of the perforations in the perforated web.

The invention is now described in more detail with reference to a number of alternative embodiments adapted for continuous operation and with the aid of the accompanying drawings, in which:

Figure 1 illustrates diagrammatically in side view one embodiment of the invention adapted to continuous operation;

Figure 2 is a diagrammatic representation in which molten polymeric composition is extruded into the nip of the apparatus;

Figure 3 illustrates diagrammatically

another embodiment of the invention in which the product is cooled from the side of the web distant from the heated roll;

5 Figure 4 illustrates a modification of the invention in which both back and nip cooling are employed.

10 Figure 5 illustrates diagrammatically an apparatus in which one heated roll is used and the filament forming material is held against the surface of the roll only by the tension in the web.

Figure 6 illustrates a process in which the filament forming material moves away from the heated roll over a guide roll;

15 Figure 7 illustrates a process in which a second filament forming composition is supplied.

20 With reference to Figure 1, 1 is a web, e.g. a woven fabric for example "Terylene" (Registered Trade Mark) voile, and 2 is a film of a thermoplastic polymeric composition which is fed from the roll to the nip between contra-rotating rolls 3 and 4. The surface of the rolls may be of metal if desired but it may be advantageous to use materials of lower thermal conductivity, e.g. stoneware, ceramic, concrete or glass. The surface may be smooth and may be polished but the use of surfaces that have been roughened e.g. by abrasion (e.g. to produce a "Satin" finish), grinding, shot-blasting or knurling, is not excluded and may be preferred. The film, which optionally is preheated to a temperature above its softening point, but not to a temperature at which it becomes inconvenient to use, is fed to the nip between the rolls, preferably at least one of which is driven, and is separated from roll 4 by the web. Roll 3 is heated to a temperature at which the filament forming material will adhere to it, the heat being supplied, for example by heating the interior with e.g. steam, electricity or hot oil in conventional manner. Roll 4 is preferably maintained at a temperature below the softening point of the polymeric material and, if desired, contains cooling means, e.g. a supply of fluid to the interior of the roll at a suitable temperature, to prevent the polymeric material sticking to it. The use of a non-stick surface on the surface of roll 4, e.g. a thin layer of polytetrafluoroethylene or silicone, may be desirable. 5 is a nozzle, slotted tube or series of nozzles connected to a suitable supply, by means not shown for projecting a stream or streams of cooling fluid, suitably compressed air, into the out-running nip between the heated roll 3 and the outcoming composite web and film, to cool the web and the filaments or tufts at a point before separation of the filaments from the heated surface occurs. 6 is a pile surfaced product leaving the nip.

65 The temperature of the extruder die or polymer preheating means (where these are

used), the temperature of the rolls and the temperature and pressure of the coolant fluid will be chosen with regard to the nature of the filament forming composition employed and the type of product (e.g. length and density of the filaments or tufts forming the pile) required, and their selection will present no difficulty to the skilled man. For example, if the composition is a thermoplastic and is too hot it may sag, although this may be avoided by feeding it vertically downwards into the nip. Again, at too high a temperature, degradation may occur unless precautions are taken. Where aerial oxidation is likely a cooling of inert gas, for example nitrogen, helium or carbon dioxide may be employed instead of air, and where very oxygen-sensitive polymers are employed blanketing using nitrogen or another suitable inert gas may be necessary. If the film is not hot enough the pile may be of poor quality or discontinuous in nature.

The temperature of the hot surface affects the nature of the fibrous or tufted surface of the product. Thus, if the composition is a thermoplastic polymer as the temperature of the roll is increased above that at which individual filaments or tufts are formed in substantially regular and dense fashion, more of the polymer tends to stick to it leading initially to the fusion of the tops of adjacent filaments or tufts and the subsequent production of a more or less continuous surface over irregular areas. On the other hand, if the roll is too cool, the filament or tuft formation may become sparse and irregular.

The temperature of the other (or backing) roll or surface is less critical but when the web is porous it has either to be cool enough to prevent any polymer sticking to it but not so cool as to unduly increase the viscosity of the plastics and prevent its penetration of the web and/or it has to be rendered non-stick either by being itself or inherently non-stick material or by having a coating of non-stick material, e.g. "Fluon" (Registered Trade Mark) or a silicone.

Figure 2 shows apparatus similar to that of Figure 1, except that it is arranged for use with a polymeric composition having a sharp melting point and/or relatively low viscosity in the molten form e.g. crystalline polyamides and polyesters. The apparatus is arranged so that a film of molten composition is extruded downwards into the nip between rolls 3 and 4 from extruder 8. The backing roll 4 is shown with a resilient surface. Alternatively, the polymeric composition may be extruded on to the heated roll and "cast" to the desired film configuration thereon prior to entering the nip.

Figure 3 shows apparatus in which the emerging product is cooled by blowing a stream of cold air or other fluid against the side of the web distant from the pile. The

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cooling effect is increased if the web is porous, so allowing the air to pass through it into the fibrous layer.

Figure 4 shows part of an apparatus in which both back and front cooling of the web are employed. The surface of the web distant from the heated surface is cooled by contacting it with the surface of a tube 9 through which is passed a cooling fluid. The tube is disposed at right angles to the direction of travel of the web and parallel with the axis of roller 3. Front cooling by feeding a stream of cooling gas between the fibres in the exit nip is employed also.

Figure 5 illustrates diagrammatically apparatus in which one heated roll is used, the web and polymeric material are held against the surface of the roll for long enough for bonding and adhesion to take place, as described previously, only by tension in the web. The web supply roll 10 is braked or otherwise retarded and the product take-up roll 11 is driven at a take-up speed the same as that of surface speed of roll 3. Resilient means, suitable sprung rollers, may be employed to assist in tensioning the web. Roll 3 may be driven or rotate passively, its speed of rotation being controlled by the speed of roll 11.

Figure 6 illustrates a process in which a guide roll 12 is provided to control the "take off angle" at which the product leaves the heated surface in apparatus generally as shown in Figure 5. The roll 12 may be cooled.

According to a modification of the process of the invention illustrated in Figure 7 which allows for yet further variation of the product, a second filament forming polymeric composition (in the illustration represented by 13) is supplied either between the heated surface and the first polymeric composition between the web and the first polymeric composition or between the web and the pressure-applying means. This second composition is preferably supplied in the form of a film and can be of the same or different colour. In an alternative embodiment, it may be applied, e.g. by sprinkling powder or granules on to a film of the first composition or on to the web.

The present invention is further illustrated but in no way limited by the following Examples.

Example 1

Apparatus generally as illustrated in Figure 1 (except that roll 4 was provided with a resilient surface) was employed to produce a pile-surfaced product as follows:—

A non-woven web of continuous melt-bonded bi-component filament fibres, of weight 1/3 oz per square metre was passed,

with a film of low density polyethylene (0.001" thick "Alkathene" (Registered Trade Mark)), through the nip. The heated roll temperature was 115—125° C and roll surface speed 9"/min.

The resilient layer on roll 4 consisted (in order from nearest the centre) of heavy canvass, 1/2" thick layer of closed cell Neoprene foam and a non-stick surface of 1/16" thick silicone rubber sheet.

The cooling air pressure was 20 p.s.i. fed into the outgoing nip from a distance of 5" from a tube perforated with holes 1/32" diameter, 1/4" apart.

The product obtained had a pleasing appearance of a piled surface of polyethylene fibrils backed by the layer of the non-woven fabric.

Example 2

Apparatus as shown in Figure 3 was employed to make a pile-surfaced product according to the invention. The web was woven "Terylene" (Registered Trade Mark) net (30 gm per square metre) having perforations 2 mm side. The polymeric composition was low density polyethylene ("Alkathene" (Registered Trade Mark)) sheet 2/1000" thick. Roll 3 was heated to 120°C and roll 4 was surfaced with a layer of flexible polyurethane foam 12 mm thick. Throughput speed was 20 cm/min. The nip pressure employed was about 60 p.s.i.

The web surface away from the heated roll was cooled by a stream of air at ambient temperature and 10 p.s.i., supplied from a slit nozzle situated 15 cm from the heated roll and located to direct the air at the area of sheet just prior to and at the point of its separation from the heated roll.

Hereagain, a pleasing pile-surfaced product was obtained.

Example 3

This example used an apparatus as shown in Figure 4 (except that roll 4 had a soft polyurethane foam surface 15 mm thick). The web 1 was a non-woven rayon paper of weight about 20 gm per square metre ("Roller wipe") and the polymeric composition 2 a film 2/1000" thick of low density polyethylene. Operating conditions were generally as described in Example 1, except that an additional cooling means comprising a cold pipe, 18 mm outside diameter, was used through which was circulated water at 15° C. This cold pipe was located about 2 mm from the heated roll (i.e. sufficiently far to allow passage of the web/polymeric composition composite between it and the surface without forming a nip).

The product had pile surface comprising very short fibrils.

Example 4

In a process using apparatus as illustrated in Figure 2, molten polyethylene was fed from the extruder, the polyethylene was "Alkathene" (Registered Trade Mark) the extruder die nip to roll nip distance was 5", the coolant jet to roll nip distance was 1" and the coolant air pressure was 50 p.s.i.g. The die (which was a slit 10" long and 0.06" wide) temperature was 200° C the heated roll temperature was 115° C. and the roll force 1400 lb. Roll speed was 12"/min. The web employed was "Terylene" (Registered Trade Mark) 15 meshwarpknit net.

The product obtained had a short polyethylene pile surfaced backed with the "Terylene" (Registered Trade Mark) net.

Example 5

Apparatus as shown in Figure 5 was employed to produce a low density polyethylene "Alkathene" (Registered Trade Mark) pile on a woven "Terylene" (Registered Trade Mark) net of perforation size 2 mm and 30 gm/M². The polyethylene was in the form of a film 3/1000" thick. The roll was heated to 180° C ± 20° C. (This rather high temperature was preferred to reduce the viscosity of the polymeric material so that flow into the perforations of the net occurred satisfactorily). A stream of air at ambient temperature was directed as shown in the Figure from a split nozzle situated 5 cm from the point at which the film left the roll surface. The polymeric material contacted the surface of the roll (which was of diameter 25 cm) for a distance of 30 cm—equivalent to about 1 minute 20 seconds. Tension of a few kilograms was applied to the web by retarding supply roll 10 by means of a simple friction brake and driving roll 11 at an appropriate speed.

Example 6

Example 5 was repeated using a web of non-woven rayon "paper" of weight about 20 gm per square metre ("Roller wipe"), the polymeric material being a film 2/1000" thick of low density polyethylene.

A product comprising low density polyethylene pile bonded to paper was obtained.

Example 7

Example 1 was repeated using a welded web and a film of low density polyethylene 1/1000" thick.

The tension of the web in each of Examples 5, 6 and 7 was adjusted to maintain both web and polymeric composition in close contact with the roller surface without causing the web to break.

Under carefully controlled conditions, the pile-surfaced products of our process may be shaped, e.g. by vacuum forming. By this

means, for example, stair coverings preformed to the shape of the stairs may be obtained. Care must be taken during the shaping process, however, to avoid subjecting the products to conditions which would destroy the pile.

Applications for the products of our process include, for example floor and ground coverings, e.g. in place of carpets, for swimming pool surrounds, deck coverings for boats, indoor and outdoor tennis court surfaces, golf ranges, indoor and outdoor running tracks, bowling greens, ski and toboggan slopes, mats, bathmats, bowling, beer and curling mats; upholstery, e.g. for vehicles, deck chairs, garden furniture, loose covers, cushion covers; linings, e.g. for outer cold-weather garments, suitcases, cat and dog baskets, cutlery drawers, jewel cases and coffins; wall and ceiling coverings; card table tops; ornamental textured surfaces, e.g. for garments, millinery, footwear, shopping bags, handbags, academic, clerical and civic regalia and stage scenery and costumes; simulated fur; sound absorbent articles e.g. as buffers for lids and doors and as mats for typewriters, sewing machines, calculating machines, washing machines and dishwashers; conveyor belting, especially for retaining cylindrical or spherical objects; artificial surfaces for aquaria; supports for organisms in biochemical processes e.g. in water treatment oyster beds, polishing mats, filter media, towelling and paint stippling pads.

Soft easily flexible pile-surfaced material produced by the method of the invention was found to be particularly useful in the manufacture of cheap disposable articles, including towelling and clothing, it may find application, for example, in the production of disposable surgical wear, such as surgical gowns, hats, masks and overshoes.

WHAT WE CLAIM IS:—

1. A process for the production of a pile surfaced sheet material which comprises the steps of interposing a softened or heat softenable filament forming composition between a foundation layer and a heated roll having a smooth or roughened surface holding the foundation layer against the softened composition so that bonding of the composition to the foundation layer and adhesion of the composition to the surface of the heated roll occurs, parting the composition from the heated roll so that filaments or tufts of the softened composition are formed between the foundation layer and the heated roll, hardening the filaments or tufts so formed by a stream of cooling fluid and separating them from the heated roll.

2. A process according to Claim 1 in which the foundation layer and the filament

Example 4

In a process using apparatus as illustrated in Figure 2, molten polyethylene was fed from the extruder, the polyethylene was "Alkathene" (Registered Trade Mark) the extruder die nip to roll nip distance was 5", the coolant jet to roll nip distance was 1" and the coolant air pressure was 50 p.s.i.g. The die (which was a slit 10" long and 0.06" wide) temperature was 200° C the heated roll temperature was 115° C. and the roll force 1400 lb. Roll speed was 12"/min. The web employed was "Terylene" (Registered Trade Mark) 15 meshwarpknit net.

The product obtained had a short polyethylene pile surfaced backed with the "Terylene" (Registered Trade Mark) net.

Example 5

Apparatus as shown in Figure 5 was employed to produce a low density polyethylene "Alkathene" (Registered Trade Mark) pile on a woven "Terylene" (Registered Trade Mark) net of perforation size 2 mm and 30 gm/M². The polyethylene was in the form of a film 3/1000" thick. The roll was heated to 180° C ± 20° C. (This rather high temperature was preferred to reduce the viscosity of the polymeric material so that flow into the perforations of the net occurred satisfactorily). A stream of air at ambient temperature was directed as shown in the Figure from a split nozzle situated 5 cm from the point at which the film left the roll surface. The polymeric material contacted the surface of the roll (which was of diameter 25 cm) for a distance of 30 cm—equivalent to about 1 minute 20 seconds. Tension of a few kilograms was applied to the web by retarding supply roll 10 by means of a simple friction brake and driving roll 11 at an appropriate speed.

Example 6

Example 5 was repeated using a web of non-woven rayon "paper" of weight about 20 gm per square metre ("Roller wipe"), the polymeric material being a film 2/1000" thick of low density polyethylene.

A product comprising low density polyethylene pile bonded to paper was obtained.

Example 7

Example 1 was repeated using a welded web and a film of low density polyethylene 1/1000" thick.

The tension of the web in each of Examples 5, 6 and 7 was adjusted to maintain both web and polymeric composition in close contact with the roller surface without causing the web to break.

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means, for example, stair coverings pre-formed to the shape of the stairs may be obtained. Care must be taken during the shaping process, however, to avoid subjecting the products to conditions which would destroy the pile.

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Soft easily flexible pile-surfaced material produced by the method of the invention was found to be particularly useful in the manufacture of cheap disposable articles, including towelling and clothing, it may find application, for example, in the production of disposable surgical wear, such as surgical gowns, hats, masks and overshoes.

WHAT WE CLAIM IS:—

1. A process for the production of a pile surfaced sheet material which comprises the steps of interposing a softened or heat softenable filament forming composition between a foundation layer and a heated roll having a smooth or roughened surface holding the foundation layer against the softened composition so that bonding of the composition to the foundation layer and adhesion of the composition to the surface of the heated roll occurs, parting the composition from the heated roll so that filaments or tufts of the softened composition are formed between the foundation layer and the heated roll, hardening the filaments or tufts so formed by a stream of cooling fluid and separating them from the heated roll.
2. A process according to Claim 1 in which the foundation layer and the filament



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forming composition are held against the heated roll by resilient means.

3. A process according to Claim 1 in which the foundation layer is held against the filament forming composition and the heated roll by tension in the foundation layer.

4. A process according to any of the preceding claims in which the stream of cooling fluid is a gas.

5. A process according to any of Claims 1 to 4 in which the filaments or tufts are hardened by cooling the side of the foundation layer distant from the heated roll.

6. A process according to Claim 4 or Claim 5 in which the filaments or tufts are hardened by cooling the side of the foundation layer distant from the heat roll by a stream of cooling gas directed at the web at a pressure between 10 lb/sq. in. and 60 lb/sq. in.

7. A process according to Claim 6 in which the stream of cooling gas is directed at a pressure between 20 and 30 lb/sq. in.

8. A process according to any of the preceding claims in which the foundation layer is porous or perforated.

9. A process according to Claim 8 in which the cooling is achieved by a stream of gas directed against the side of the foundation layer distant from the heated roll which passes through the foundation layer into the fibril forming area.

10. A process according to any of the preceding claims in which the foundation layer and the filament forming composition pass between a nip formed between the heated roll and a cooled roll.

11. A process according to any of the preceding claims in which the composition is parted from the heated roll by withdrawing the foundation layer with the composition adhering thereto over a cooled roller, rod or tube.

12. A process according to any of the pre-

ceding claims in which the foundation layer is withdrawn from the heated roll at an angle of between 30 and 80° to the tangent to the surface of the heated roll at the point where it leaves the roll.

13. A process according to any of the preceding claims in which a porous or perforated layer is placed adjacent to the heated roll, the softened filament forming composition is pressed through the porous or perforated layer into contact with the heated roll and after separation from the heated roll and hardening of the filaments or tufts the porous or perforated layer is removed from the hardened filament forming material.

14. A process according to any of the preceding claims in which the softening of the filament forming composition is effected by the heated roll.

15. A process according to any of the preceding claims in which the filament forming composition is an addition or condensation polymer, optionally in the form of a laminate.

16. A process according to any of Claims 1 to 12 in which the filament forming composition is a glass, particularly a low melting glass.

17. A process according to any of the preceding claims in which the foundation layer is paper.

18. A process substantially as hereinbefore described with particular reference to the accompanying drawings.

19. A process substantially as hereinbefore described with particular reference to the accompanying examples.

20. A process according to the invention and substantially as hereinbefore described.

21. A pile surfaced product whenever produced by a process according to any one of the preceding claims.

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Agent for the Applicants

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