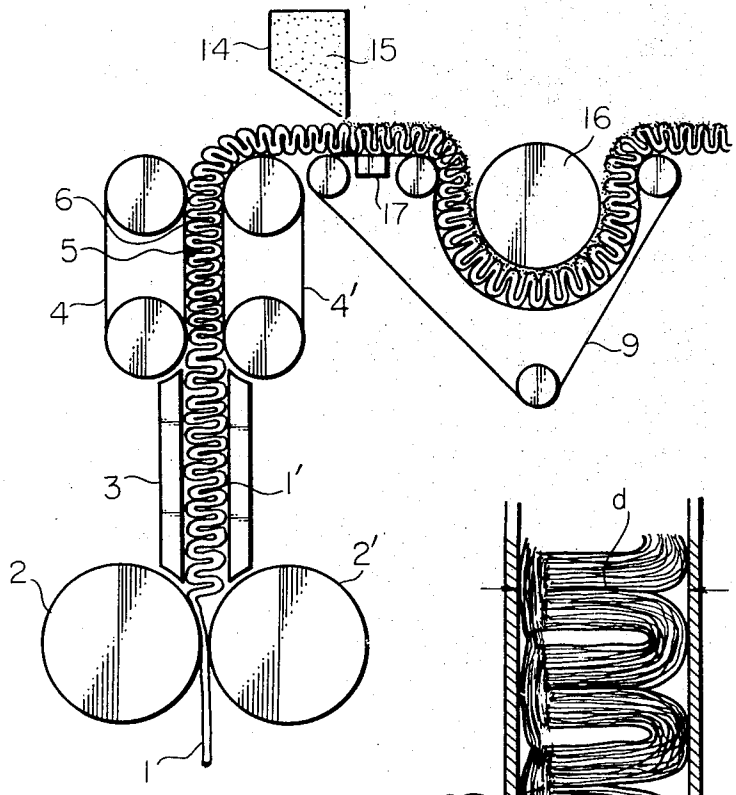
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July 25, 1972 MASAO FUKUDA ET AL 3,679,533

LOOP PILE FABRIC AND METHODS FOR MANUFACTURING SAME

Filed Oct. 13, 1970 4 Sheets-Sheet 1

Fig. 1



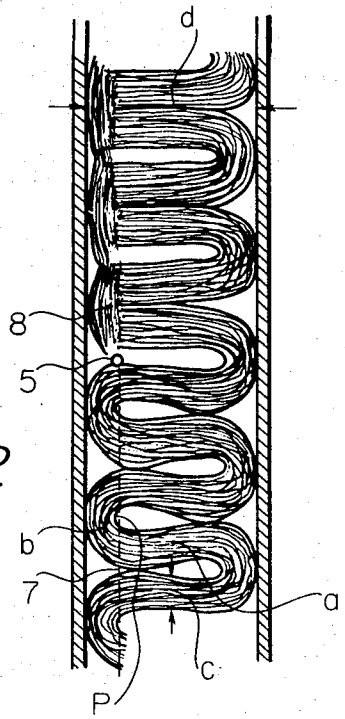


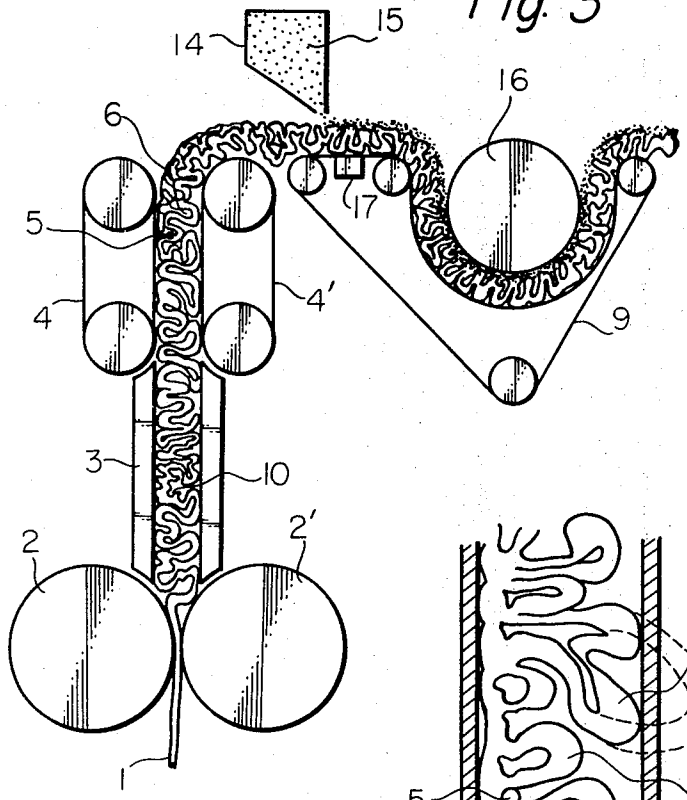
Fig. 2

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LOOP PILE FABRIC AND METHODS FOR MANUFACTURING SAME

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Fig. 3



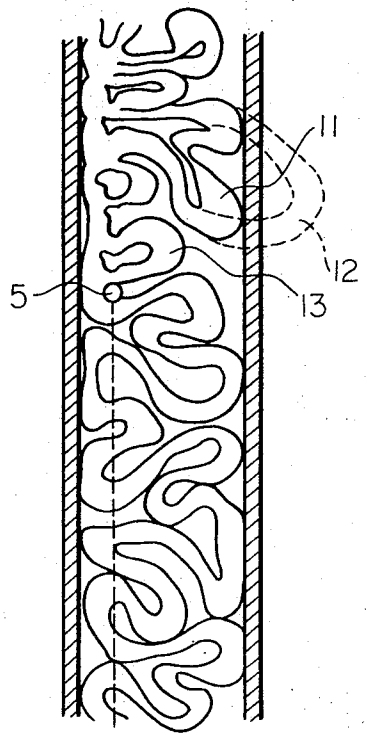


Fig. 4

LOOP PILE FABRIC AND METHODS FOR MANUFACTURING SAME

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Fig. 5

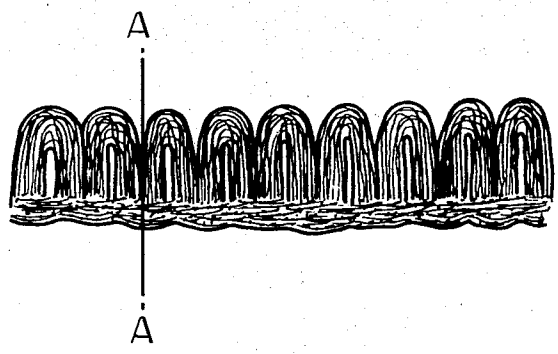


Fig. 6

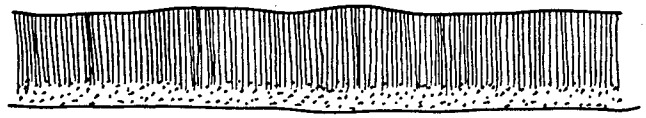
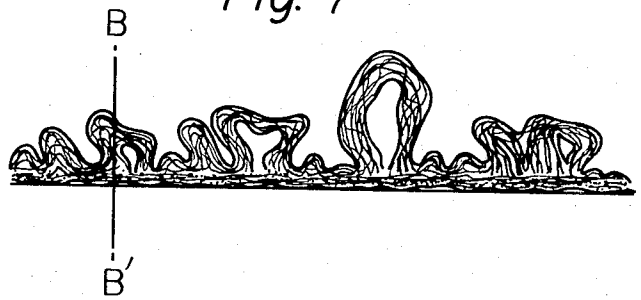


Fig. 7



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LOOP PILE FABRIC AND METHODS FOR MANUFACTURING SAME

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Fig. 8

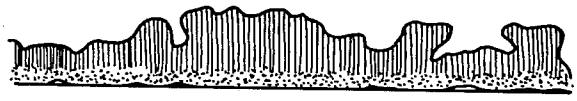


Fig. 9

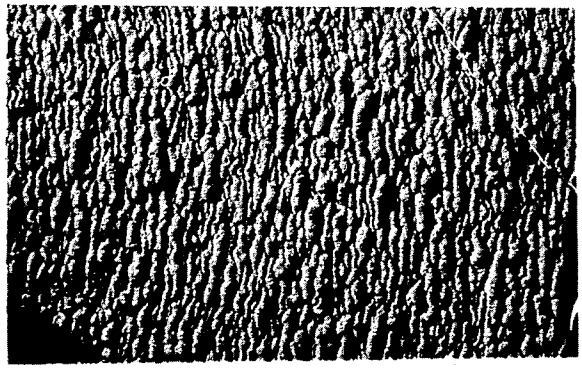
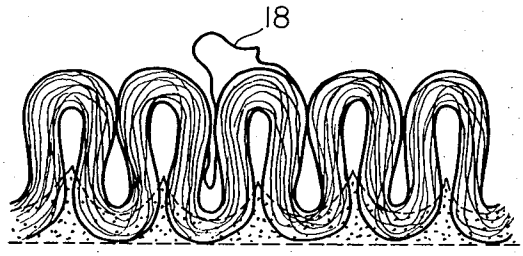


Fig. 10



United States Patent Office 3,679,533 Patented July 25, 1972

3,679,533

LOOP PILE FABRIC AND METHODS FOR MANUFACTURING SAME

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Claims priority, application Japan, Oct. 13, 1969, 44/81,714
Int. Cl. D04h 11/00
U.S. Cl. 161—66 11 Claims

ABSTRACT OF THE DISCLOSURE

A loop pile fabric produced without the use of looms or tufting machines, the fabric being composed of thermoplastic synthetic fibers and prepared by melting and cutting a sheeting having repeated foldings into two separate zones; the backing layer and the face covering layer and fusing them again to manufacture loop pile fabric having an appealing appearance and good hand.

The present invention relates to loop pile fabric which is based on a novel type construction and presents a striking appearance to methods of and manufacturing the same.

Loop pile fabric has so far been manufactured with looms or tufting machines, but without the use of looms or tufting machines the present invention provides loop pile fabric having a novel construction, which is manufactured directly from sheeting consisting of a great number of thermoplastic synthetic filaments or fibers. The loop pile fabric of the present invention has excellent hand due to its unique construction. The sheeting in the present invention means one in which many fibers or filaments have been arranged in a sheet form such as opened tow spread in a sheet form, warp yarn arranged in a parallel side by side relationship or a sheet constructed with card webs consisting of many staple fibers.

According to the present invention a loop pile fabric is provided consisting of a backing layer of many thermoplastic synthetic fibers and a face covering layer of numerous looped fiber bundles protruding from the backing layer almost perpendicular with respect to the surface and secured to it, characterized in that the backing layer is composed of short fibers which are laid one over the other and caused to adhere to each other as a result of melting mainly near the ends of the fibers and the many looped fiber bundles are caused to adhere as a result of melting to the backing layer at the bottoms of the loops.

The loop pile fabric of the present invention as described above can be manufactured by a method characterized in that a continuous sheeting consisting of many thermoplastic synthetic fibers is folded successively into a sheet form having repeated foldings in the specifically shaped space, the resultant sheeting is passed through the space; the sheeting having repeated foldings is melted and cut with a heated wire positioned near one side in the space, transversely of the width of the sheeting so that the wire intercepts the path of the sheeting; thereby the sheeting is separated into the stratified foundations consisting of short fibers having molten and adhering cut ends and laid one over the other and the looped fiber bundles having molten and adhering ends, during which time the stratified foundations adjacent to each other adhere by melting to each other mainly near the cut ends and are connected to each other to form the backing layer and the looped fiber bundles adhere to the backing layer at the lower cut ends to form a face covering layer.

Referring to the accompanying drawings, the present invention will be described in detail below.

FIG. 1 is a flow sheet showing the cutline of one embodiment of the present invention.

FIG. 2 is an enlarged diagram showing the heated wire in FIG. 1.

FIG. 3 is a flow sheet showing another embodiment of the present invention.

FIG. 4 is an enlarged diagram showing the melt cutting in FIG. 3 and how the parts of the fiber bundles forming loops are released from a compressed state and spread after the melt cutting.

FIG. 5 is an enlarged diagram showing a cross section of the reinforced loop pile fabric of the present invention manufactured by the method of FIG. 1.

FIG. 6 is an enlarged cross section taken along line A–A′ of FIG. 5.

FIG. 7 is an enlarged cross section of the reinforced loop pile fabric of the present invention manufactured by the method of FIG. 3.

FIG. 8 is an enlarged cross sectional view taken along line B–B′ of FIG. 7.

FIG. 9 is a planar photograph of the reinforced loop pile fabric of the present invention the cross sections of which are illustrated in FIGS. 7 and 8.

FIG. 10 is an enlarged cross sectional view of loop pile fabric conventionally prepared by impregnating the sheet form of fibers folded in an accordion-like shape with resin.

In FIG. 1 a sheeting **1** consisting of thermoplastic synthetic fibers and having a width the same as the width of the loop pile fabric to be manufactured is pushed against back pressure into a stuffing chamber **3** with a pair of opposed feed rollers **2** and **2′**, and in turn folded into an accordion-like manner into a sheeting **1′** having repeated folding. This stuffing chamber has a width equal to the width of the loop pile fabric to be manufactured and has an optional determined thickness (usually about 4 to 12 mm.).

As mentioned above in folding a sheeting by pushing it into a stuffing chamber, such sheeting is uniformly folded like an accordion when the back pressure is comparatively low to make the pattern of repeated foldings regular and uniform. However, when the stuffing speed is accelerated and back pressure is raised, the foldings become very irregular at a certain back pressure, and as non-uniform foldings are repeated, the pattern of repeating foldings of the sheeting becomes very inconsistent and irregular. Once the successively repeated foldings are made irregular, regular foldings do not return even if back pressure is decreased to a lower value; even under such low pressures, the irregular foldings continue as previously. FIG. 1 shows one embodiment of the present invention in which the stuffing speed is adjusted so as irregular, regular foldings do not return even if back pressure is decreased to a lower value; even under such low back pressures, the irregular foldings continue as previously. FIG. 1 shows one embodiment of the present invention in which the stuffing speed is adjusted so as to keep a comparatively low back pressure and generate continuously the regular foldings of the sheeting. The sheeting **1′** having a pattern of regular foldings leaves the stuffing chamber and moves forward at a given speed while being held by a pair of opposed conveyor belts **4** and **4′**. A heated wire **5** (for instance a wire electrically heated) is positioned in the space defined by the opposed conveyor belts **4**, **4′**, that is the running path **6** of the sheet is substantially parallel with the conveyor belts so that the wire intercepts the motion of the sheeting along its entire length enough to transverse the width of the sheeting. FIG. 2 is an enlarged diagram illustrating the neighborhood of the heated wire **5** positioned in FIG. 1. As shown in FIG. 2, the heated wire is disposed near either one of the conveyor belts in the

running path 6 of the sheeting and heated to such a high temperatue, usually 250 to 400° C. that when the sheeting runs in the path and comes into contact with the heated wire along its entire width, the contact portion is instantly melted and cut. Thus when the sheeting passes through the path (6), the portions in contact with the heated wire are successively cut by melting (these cut portions are shown with a dotted line 7 in FIG. 2); consequently the sheeting is cut into two separate zones: one zone (a) consisting of many looped bundles arranged in parallel and closely positioned to each other and the other zone (b) consisting of flections which form the bottom made of repeating foldings. Each flection of the bottom is composed of many curved fibers cut into short lengths and having fused cut ends. Immediately after the cutting, the component fibers extend almost in a straight line released from the curved form by their own repelling power. These many extended short fibers are stratified and form a loose construction 8 having many voids (this lose construction is called stratified foundations). At the same time the fused cut ends of fibers of the stratified foundations 8 each adhere to adjacent fused cut ends or the non-adhesive portions of fibers in the neighborhood of the cut ends, and finally all the stratified foundations are connected to form a planar layer (in the specification and claims of the present invention the planar layer thus formed is called the backing layer). The cut ends of looped fiber bundles in the zone (a) are each fused and most of them adhere to the backing layer and the rest adhere to the adjacent bottoms of looped fiber bundles. As a result the loop pile fabric of the present invention having a novel construction such that many looped fiber bundles closely positioned to each other on the side of bundles protrude almost perpendicular, and secured, to the backing layer, can be manufactured. The loop pile fabric thus manufactured is taken out of the path (6) with the belts 9. The layer composed of many looped fiber bundles manufactured as described above is called a face covering layer in the specification and the claims.

The loop pile fabric of the present invention can be continuously manufactured from a fibrous sheeting by simple proceedings. Accordingly the process of the present invention is more economical than conventional processes with looms or tufting machines. Further the loop pile fabric of the present invention presents a beautiful appearance and an excellent hand because of its unique construction. Since the face covering layer adheres by fusing securely to the backing layer, the fabric has considerable dimensional stability as a whole. Thus for instance it can be put into an interior decorative use by sticking it to the wall as it is. However, the adhesive strength between the covering layer and the backing layer is not sufficient for use as floor covering like carpets, and it is impossible to use it as a carpet as it is.

Therefore, use as a carpeting material is not possible until the bottom of the loop pile fabric is impregnated with a reinforcing agent such as resinous materials or rubber-like materials to strengthen the adhesion of the covering layer to the backing layer (later described).

In the method of manufacturing the loop pile fabric of the present invention as described with reference to FIG. 1, if substantially the whole of the fibers made up to the regular and uniform repeating foldings of the fibrous sheeting is cut by melting with a heated wire, the maximum degree of adhesion by melting between the covering layer and the backing layer is obtained, resulting in higher dimensional stability of the fabric. The loop pile fabric of such an embodiment of the present invention is highly desirable.

In order that such loop pile fabric may be manufactured, sheeting having regularly repeated foldings should be manufactured and a heated wire should be positioned at a distance about equal to the thickness of the sheeting from either one of the conveyor belts (generally speaking, one side wall defining the space where the sheeting passes through). The thickness of the sheeting is shown by *c* in FIG. 2. The positioning of the heated wire in this way is to position the wire near a minimum point P inside a curve of a fold. Substantially all of the fibers of the sheeting are cut by melting and the total number of short fibers made up to the backing layer becomes substantially equal to the total number of short fibers made up to the looped fiber bundles of the covering layer. The loop pile fabric thus manufactured is of pile construction in which the ribs of the same height (also called pile length) and the same width are arranged in parallel. Further the desirable position of the heated wire is as described above, but the above-mentioned positioning of the wire is not essential and may be slightly altered. Generally speaking it is desirable to position the wire at a distance from 0.5 mm. or above from the surface of conveyor belt on the backing layer side to ⅗ or below of the thickness (shown as *d* in FIG. 2) of the stuffing chamber. It is not desirable that the amount of molten fibers caused by the heated wire be too great. This amount of molten fibers depends mainly upon the temperature and diameter of the heated wire. It is preferable to melt the fibers located within a circle having a diameter about two or three times the diameter of the heated wire. The diameter of the wire is usually about 0.1 to 0.8 mm., preferably 0.2 to 0.4 mm. It is most convenient to use an electric heating wire as the heated wire.

Another embodiment for which the loop pile fabric of the present invention is suitable is high- and low-loop pile fabric, which has a pattern of very irregular, repeated foldings. The height and width of a rib vary completely irregularly within a rib as well as from rib to rib, and by the parallel arrangement in high density of these numerous non-uniform ribs, the fabric abounds in visual and tactile varieties and presents a gorgeous appearance. In manufacturing the high- and low-loop pile fabric having such characteristics, the apparatus in FIG. 1 can be used with a slight change in procedure. Thus it is simply and cheaply manufactured. The methods of manufacturing the high- and low-loop pile fabric will be described referring to FIGS. 3 and 4.

In FIG. 3 apparatus the same as that of FIG. 1 is used. Sheeting 1 consisting of thermoplastic synthetic fibers is pushed into a stuffing chamber 3 against back pressure with a pair of rollers 2, 2′ as in FIG. 1. The methods in FIG. 3 are different from those of FIG. 1 in that a pattern of repeated foldings of sheeting in the stuffing chamber 3 is made irregular. In order that an irregular pattern of repeated foldings may be given to the sheeting, as described above the stuffing speed may be temporarily increased to generate a back pressure higher than a critical back pressure in the stuffing chamber, and thereby the repeated foldings make an irregular pattern by themselves. Afterwards this irregular pattern of foldings is continuously maintained even after the stuffing speed is decreased and the back pressure is lowered below the critical value for the back pressure. Besides the above-mentioned method it is possible to give irregularities to the repeated foldings by temporarily suspending or decreasing the feeding rate of part of sheeting at the nip of the feed rollers 2, 2′ or by deforming the mass of the regular pattern of repeated foldings formed in the stuffing chamber with a rod or the like and changing it into an irregular pattern. Once an irregular pattern of repeated foldings is given by a temporary deforming action described above, return to the previous regular pattern does not occur and the pattern continues to be irregular even if the deforming action is removed and the procedure is continued under conditions that without such a disturbing action, a regular pattern of repeated foldings would have been obtained. In FIG. 3 sheeting 10, leaving the stuffing chamber, being held with a pair of conveyor belts 4, 4′, and running through the path 6 defined by the conveyor belts, is melted

and cut with a heated wire (5) disposed in the path. This is identical with the method in FIG. 1. FIG. 4 shows in an enlarged diagram the condition of the cutting by melting of fibers around the heated wire **5**. As in FIG. 1, numerous fibers prepared by cutting the curves of the bottom form stratified foundations having a loose construction, in which the fibers are laid one over the other and connect each other to make a backing layer. On the other hand, the looped fiber bundles leave the space defined by conveyor belts **4, 4'** and are released from the holding by the conyevor belts **4, 4'**. Then, for instance, a looped fiber bundle folded compact substantially in the middle as shown in FIG. 4 as **11** spreads outward as shown by a dotted line **12** to make a high loop, and consequently this big loop as compared with a small loop **13** makes a big difference in pile length. In such a way, the face covering layer, in which the height and width of ribs vary very irregularly, is formed and subjected to fusion to the backing layer to manufacture high- and low-loop pile fabric of the present invention. One embodiment of the manufacture of high- and low-loop pile fabric will be described below.

Sheeting prepared by arranging in parallel crimped 2100 denier nylon and a chamber for stuffing the sheeting, 7 mm. thick are used. When the feed rollers **2, 2'** speed is about 3 to 8 times the speed of conveyor belts, **4, 4'**, a pattern of regular repeated foldings is obtained, and when this exceeds the conveyor belts speed 8 times; that is, the back pressure exceeds a critical back pressure value the pattern of repeated foldings becomes irregular.

As described above, if the loop pile fabric of the present invention is to be used as floor covering like a carpet, the entire backing layer and the bottom side of the covering layer of the fabric should be impregnated with reinforcing agent such as resinous materials or rubber-like materials to secure the adhesion of both layers. Such impregnation is described referring to FIG. 1.

The loop pile fabric which has left the path **6** defined by conveyor belts **4, 4'** is advanced with belt **9** and is impregnated with a reinforcing agent **15** such as liquid resinous materials or rubber-like substances fed from a supply tank **14** located on the backing layer side of the fabric by applying the agent with a doctor knife or pressing it with rollers from the backing layer side. The fabric is heated with heated rollers **16** to harden the impregnated reinforcing agent and strengthen the adhesion between the backing layer and the covering layer. The high- and low-loop pile fabric in FIG. 4 is reinforced by the same procedure described above with reinforcing agent with respect to the adhesion of the backing layer and the covering layer and produces carpets having an irregular pattern of pile and a novel and gorgeous feeling, different from conventional carpets. The liquid resinous material to be used in the present invention is, for instance, polyvinyl chloride plastisol of a well-known type or the liquid rubber-like material is, for instance, latex of SBR series of a well-known type. FIGS. 5 and 6 are enlarged cross sectional views of the reinforced loop pile fabric of the present invention having a pattern of regular, repeated foldings; FIGS. 7 and 8 are enlarged cross sectional views of the reinforced loop pile fabric of the present invention having a pattern of irregular repeated foldings; FIG. 9 is a photograph showing the surface of the fabric in FIG. 8.

The reinforced loop pile fabric of the present invention as described above has high elasticity, a good hand and comfort in use particularly when it is reinforced with porous resinous materials. Such a reinforced loop pile fabric can be manufactured by the methods of applying plastisol or organosol containing foaming agents to the backing layer side of the loop pile fabric of the present invention, sucking this sol from the surface side under the condition that the applied sol does not gell to impregnate the inner part of the fabric with it, heat treating the permeated sol at temperatures at which it is foamed and gelled and forming a porous resinous body within the loop pile fabric. In FIGS. 1 and 3 a vacuum nozzle **17** positioned opposite a supply tank **14**, downstream from it and upstream from a heating roll **16** is for sucking the applied sol inside the loop pile fabric. One example of an applied agent is polyvinyl chloride resin. A plastisol consisting essentially of 100 parts of polyvinyl chloride resin, 30 to 150 parts of plasticizer, 0 to 80 parts of filling agent, 13 to 15 parts of the foaming agent and a stabilizer is used. About 50 to 150% of the plastisol based on the weight of the fibers is preferably applied. The temperature at which a plastisol is foamed and gelled depends upon the selection of the plastisol, and for instance in the case of the plastisol of polyvinyl chloride, it is 180 to 190° C. Any foaming agent may be used if it is foamed and gelled at temperatures which do not damage fiber properties. Among these are azodicarbonamide, urea compounds azobisisobutyronitrile, diphenyl sulfone-3,3'-disulfonylhydrazide, etc.

If necessary, one in which cloth or non-woven fabric is applied to the back side of the reinforced loop pile fabric of the present invention can be manufactured.

The loop pile fabric, reinforced or not, manufactured by the methods of the present invention can be a cut pile fabric by scissoring conventionally the upper ends of the loop pile. In FIGS. 1 and 3, a heated wire is disposed only near one side, but by disposing two wires on both sides, backing layers are prepared on both sides. By cutting the middle pile between two backing layers along a plane parallel to them, two separate cut pile fabrics are obtainable.

The loop pile fabric of the present invention has an excellent adaptability for the impregnation with resinous or rubber-like materials because of its structural characteristics in the following respects: First, the loop pile fabric of the present invention has considerable dimensional stability by the adhesion of the backing layer and the covering layer without the reinforcement by resin or the like. As a result, when after-treatments such as resinous permeation are given, there is no need to hold it and against various after-treatments the folded state of the piles remains and is stabilized dimensionally. Secondly, the backing layer of the fabric consists of short fibers caused to adhere to each other mainly by their fiber ends and makes an organized layer of these fibers loosely arranged in layers and having numerous voids; thus the permeation of liquid resinous or rubber-like materials is easily and uniformly carried out. Thirdly, the fiber ends cut by a heated wire are enlarged by melting and form deformed portions having much greater diameters as compared with the diameters of the fibers. Such deformed fiber ends are caused to adhere to other fibers by their adhesive power. When this adhesive structure is reinforced with permeated resinous or rubber-like materials, the resistance to peeling and falling-off of adhering fibers is increased by the action of the deformed portions as compared with the adhesiveness of usual fiber ends. The durability of the reinforced loop pile fabric is remarkably improved. The loop pile fabric of the present invention has such various advantages. However in conventional methods of manufacturing loop pile fabric in which the fibers or card web arranged in a sheet form is folded in an accordion-like shape and one side of the sheeting is impregnated with resin and the pile is secured and caused to adhere to each other at the layer impregnated with the resin without the use of looms or tufting machines, it is difficult to impregnate the folded pile uniformly with resin. That is, as shown in FIG. 10, the bottom curves are distinct from the void portions held between the bottom curves due to the relative difficulty of impregnation. The void portions are easier to impregnate and more resin will penetrate there and less resin will be found at the curves. As a result parts of looped fibers are caused not to adhere or to adhere very insufficiently. Thus fibers tend

to very easily fall off of the pile structure and as the separated looped fibers are continuous across many loops, the separation is in turn spread from loop to loop to present very unattractive appearance. This is a serious drawback of the conventional method. In FIG. 10 numeral **18** shows the separated loop of fibers. Another drawback of this method is that the sheeting folded like an accordion has no dimensional stability by itself; therefore in impregnating the sheeting with resin, the folded sheeting should be held in place so that the folded state is not disturbed; accordingly, a special device is needed or the operation becomes complicated.

Another conventional method, without the use of looms or tufting machines, of manufacturing loop pile fabric is one in which one side of the sheeting folded like an accordion by the procedure described above is melted by heating to form a film-like molten layer and to hold the pile in adhesion by the molten layer. In order that the adhesion of loop pile may be attained in sufficient strength, the amount of molten fibers should be considerably great. As a result, a film-like, hard layer is formed at the bottom of the fabric, damaging appreciably the hand or softness of the fabric. On the other hand the amount of fibers forming pile without being melted is caused to decrease very much and make a very lean, shabby-looking loop pile fabric. Further despite the effort to strengthen the adhesion of the film layer and the loop pile layer by the penetration of resin, owing to the presence of the film having a very poor penetration, the impregnation by resin becomes very difficult and it is next to impossible to reinforce the fabric with resin.

However, as described previously, the reinforced loop pile fabric of the present invention has excellent performance without any such disadvantages.

We claim:

1. In a loop pile fabric comprising a backing layer consisting of a multiplicity of thermoplastic synthetic fibers and a face covering layer consisting of a multiplicity of looped fiber bundles protruding from said backing layer substantially perpendicular with respect to the surface of said backing layer and secured to said backing layer, the improvement wherein said backing layer is composed of short fibers laid one over the other in the form of layers, said layers having numerous voids and said layers adhere to each other as a result of melting primarily near the ends of said short fibers, said looped fiber bundles being fused to said backing layer at the bottoms of the loops.

2. The loop pile fabric of claim **1** wherein the number of said short fibers is substantially equal to the number of fibers of said looped fiber bundles.

3. The loop pile fabric of claim **1** wherein said face covering layer is in the form of ribs, the height and width of said ribs varying irregularly.

4. The loop pile fabric of claim **1** wherein the adhesion of said backing layer and the bottom of said face covering layer are reinforced by impregnation with resinous or rubber-like materials.

5. The loop pile fabric of claim **4** wherein said resinous materials are porous.

6. A method for the manufacture of a loop pile fabric comprising folding in a shaped space a continuous sheeting consisting of a multiplicity of thermoplastic synthetic

fibers to generate a sheeting having repeated folding by passing said sheeting through said space; melting said sheeting having repeated foldings and cutting said sheeting with a heated wire positioned near one side in said space, transversely of the width of said sheeting so that the wire intercepts the path of said sheeting; separating said sheeting into stratified foundations consisting of short fibers having molten and adhering cut ends and laid one over the other and looped fiber bundles having molten and adhering ends, while allowing said stratified foundations adjacent to each other to adhere to each other by melting primarily near the cut ends, said stratified layers being connected to each other to form a backing layer, and adhering said looped fiber bundles to said backing layer at the lower cut ends of the loops to form a face covering layer.

7. The method of claim **6** wherein said sheeting is folded successively and regularly to generate a sheeting having repeated foldings and the heated wire is positioned at a distance substantially equal to the thickness of said sheeting from one side wall defining said space to melt and cut substantially all of the fibers of said sheeting.

8. The method of claim **6** wherein said sheeting is temporarily deformed during folding so as to form an irregular pattern of repeated foldings.

9. The method of claim **6** further including impregnating the loop pile fabric consisting of the backing layer and the face covering layer with resinous or rubber-like materials by supplying said materials from the backing layer side and curing the penetrated resinous or rubber-like materials to reinforce the adhesion of said backing layer and said face covering layer.

10. The method of claim **9** wherein the impregnation by the resinous materials is carried out by applying a plastisol or organosol containing a foaming agent to the backing layer side of the loop pile fabric, penetrating the applied sol into the loop pile fabric by sucking the sol from the face covering layer side in such a way that the sol does not gel and heat treating the penetrated sol at temperatures at which the penetrated sol is foamed and gelled, thereby forming a resinous porous body inside the loop pile fabric.

11. The method of claim **9** further including adhering cloth or non-woven fabric to the backside of the manufactured reinforced loop pile fabric.

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R. O. LINKER, JR., Assistant Examiner

U.S. Cl. X.R.

156—72, 210, 251, 254, 306; 161—67, 150, 156