

March 13, 1962

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3,024,518

METHODS OF MAKING PILE FABRICS

Original Filed June 17, 1955

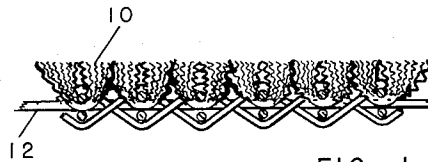


FIG. -1-

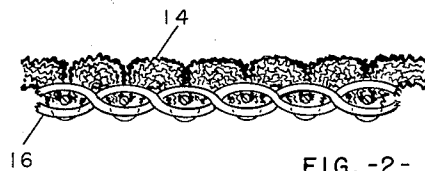


FIG. -2-

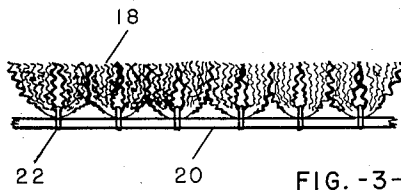


FIG. -3-

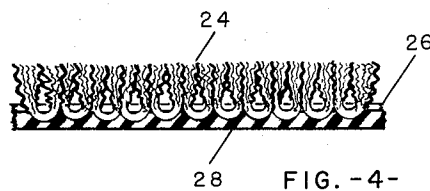


FIG. -4-

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METHODS OF MAKING PILE FABRICS

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Continuation of application Ser. No. 516,192, June 17, 1955. This application Nov. 22, 1960, Ser. No. 71,104
3 Claims. (Cl. 28—72)

This invention relates to pile fabrics of a novel construction and to methods for making the same, and more particularly the invention relates to pile fabrics in which the pile is formed from yarns having substantially undeveloped latent convolute-forming crimp therein, which crimp is developed in situ in the pile and gives improved cover, resilience, and fullness to the finished pile.

It has now been found according to this invention that superior pile fabrics can be formed by the employment of thermoplastic continuous multifilament pile yarns which have a latent substantially undeveloped crimp therein at the time of forming the pile on the backing material. Particularly, the most advantageous form of latent crimp is reflected in a differential degree of orientation of the crystallites in the yarn from one side to the other of a typical cross section of the yarn filaments, or in other words more crystallite orientation on one side of a filament than on the opposite side. The pile yarns are then subjected to a crimp or coil developing treatment, as by wet or dry heating of the fabric to a suitable temperature, in order to develop in situ in the pile per se the latent crimp in the pile yarns, which takes the form of randomly reversed generally out-of-phase coils in the filaments. This effects a general shortening of the effective length of the pile yarns and a substantial bulking of the individual pile formations as a result of the patent development of the latent coil formations in the individual yarn filaments and the consequent self-pushing apart of these filaments. Further, the development in situ of the pile yarn crimp tends to better lock the pile in place. A highly superior pile fabric, which is very suitable for rugs or the like, is formed according to this invention, the resulting fabric having considerable resilience, improved cover and fullness of the finished pile, which is superior to any previous pile fabric formed from the same quantity of yarn having substantially its full crimp therein prior to formation as the pile of the fabric.

The invention is further of importance in providing for the first time a fully acceptable pile fabric in which the pile is formed of continuous filament type thermoplastic yarns, with the resulting superior non-pilling characteristic which is achieved from the employment of continuous filament type yarns. While various pile fabrics have been formed in the past of continuous filament type yarns which have a crimp therein, there have previously been no pile fabrics which have been formed with a thermoplastic continuous filament type pile and in which the pile yarn has a substantial and material degree of latent undeveloped crimp therein at the time of formation of the pile, and in which the crimp is thereafter developed to its fullest extent in situ in the pile fabric. This is of basic importance to the present invention, for only by forming the pile of a continuous multifilament substantially undeveloped latent crimp yarn and thereafter developing this crimp in situ in the fabric pile can the results achieved by the present invention be effected. The formation or development of the crimp in the yarns prior to formation of the pile of the fabric results in a noticeably less desirable pile fabric, particularly in the reduced effective cover and fullness of the finished pile. This is a most important aspect of the invention.

While various processes may be employed for forming a suitable latent crimp yarn, I prefer to employ a non-torque crimp-forming process of the type wherein the

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yarn is passed under tension through a linear course having an acutely angular portion, as by passage over a sharp blade edge, and in which the yarn is at an elevated temperature while passing through the acutely angular portion. The desired differential degree of orientation of the crystallites in the filaments is formed by this preferred method of yarn processing. In other words, a cross section of a typical filament of the yarn shows less crystallite orientation adjacent one edge of the cross section as compared to the degree of crystallite orientation adjacent the opposite edge. With this particular yarn pre-processing the degree of crystallite orientation is less on the side of the yarn filaments which has been passed in engagement with the blade edge than that of the opposite side of the yarn filaments.

Inasmuch as the pile fabric is formed according to the invention with pile yarns having latent rather than substantial patent crimp therein a further advantage accrues in that the handling of lively yarns is not required, and the special precautions and equipment that would generally be necessary to the handling of lively yarns can be avoided.

It is another advantage of the invention that it eliminates any necessity for mechanically beating the pile fabric or other such treatment, which has heretofore been required in most instances, and thereby results in a material reduction in cost. Spun yarns must be twisted to an appreciable extent in order to give them strength, and the twist in spun yarns, when they are employed for the formation of the pile in a fabric, prevents the tufts from opening to the desired extent, apparently because the twisted yarns tend to become ensnarled and to remain an integral mass. Fabrics wherein the pile is formed from continuous filament yarns also generally require a mechanical beating to obtain any degree of opening and even then it has not been possible to readily prepare a pile fabric having the appearance and construction desired. The yarns of this invention, being continuous filament yarns, can be employed with little or no twist and, since it is a characteristic of these yarns that the curls or coils are of generally random size and distribution, the linear convolutions or curls that tend to form in adjacent filaments in the pile are predominantly out of phase. As a result the contraction of the yarn in situ in the pile results, particularly in the case of cut pile fabrics, in the opening of the tufts in the pile per se to an extent not heretofore obtainable and, in the case of loop pile fabrics, in an extremely lofty and full pile which provides a high degree of cover and resilience.

It is still another advantage that pile fabrics produced according to this invention have a reduced lustre as compared to prior art fabrics employing continuous filament yarns in the pile. When efforts have heretofore been made to substitute a continuous filament yarn for a staple fiber yarn in the formation of the pile in a fabric, the high lustre of the filaments has detracted from the overall appearance of the fabric. Pile fabrics produced according to this invention are devoid of a high lustre and have a wool like appearance so that they closely resemble fabrics woven from spun fiber yarns.

As a further advantage of the invention the number of pile tufts per unit area and the total weight of material employed can be reduced without loss of fabric quality. By employing substantially undeveloped latently crimped yarns for the formation of the pile in a fabric according to the invention, the pile tufts, under suitable conditions, contract as much as 50% or more in length, and expand 20 or more times in cross sectional area. It will readily be seen, therefore, that a much smaller number of pile tufts per unit area can be utilized without loss of cover because of the greatly increased cross sectional area of the tufts.

Other advantages of the invention include an increased

springiness and resiliency, lighter weight and a novel appearance. The new fabrics according to this invention are generally lighter in weight since the amount of basic materials employed can be reduced as mentioned above and they have increased springiness and resiliency because of the highly convoluted fibers in the pile tufts. A heavy object can be placed upon the surface of a fabric according to this invention and even after a period of hours, an imprint is barely noticeable when the object is removed.

Yarns in which the crimp is formed or substantially developed prior to formation of the pile fabric are not satisfactory for use in the new process of this invention. Further, torsionally stressed yarns such as those prepared by the method of United States Patent No. 2,564,245 are not generally suitable for a number of reasons. The first reason is that the filaments in the yarns tend to twist and become entangled to the extent that the desired high degree of expansion in cross sectional area is not achieved. A second reason that such yarns are not generally satisfactory is that torsionally stressed elasticized yarns of the high deniers generally necessary for the manufacture of pile fabrics are extremely difficult to handle due to their excessive liveliness, and in addition are so difficult to prepare that the cost thereof might prohibit their use even if the yarns were otherwise satisfactory. Yarns which are elasticized by a mechanical crimping technique, for example by a process of the type wherein the yarns are overfed into a chamber, or are fed between intermeshing gear wheels, so that the filaments thereof are bent and distorted, are generally unsatisfactory for use in this invention since the convolutions or linear distortions in adjacent yarn filaments are to a large extent in phase and since any degree of contraction is not great enough to give the desired results. It has been found that only with yarns wherein the finally developed linear convolutions in adjacent fibers are predominantly out of phase and the degree of contraction is in excess of about 15%, is the desired effect obtained.

The invention is applicable to any type of pile fabric and the accompanying drawings illustrate various types of upholstery and floor covering fabrics according to the invention.

FIGURE 1 is a cross-sectional view of a floor covering fabric according to this invention.

FIGURE 2 is a cross-sectional view of a plush upholstery fabric.

FIGURE 3 is a cross-sectional view of a false chenille fabric.

FIGURE 4 is a cross-sectional view of a tufted fabric.

It is, however, not intended that the drawings accurately represent the exact nature of the convolutions in the pile fibers nor accurately represent the exact appearance of the pile since the convoluted pile fibers produced according to this invention cannot readily be accurately portrayed in a drawing.

With reference to the drawings in greater detail, there is illustrated in FIGURE 1 a cut pile fabric of conventional weave. The pile fibers 10 have been fully developed in situ in the fabric according to the invention and are highly convoluted, the convolutions being predominantly out of phase so that the pile tufts expand greatly in cross-sectional area. The base of the fabric indicated by the reference numeral 12 can be woven from any conventional yarn.

In FIGURE 2 there is illustrated a loop pile upholstery fabric of a plush or velvet weave. The in-situ-developed pile fibers in the loops, indicated by the reference numeral 14, expand in cross-sectional area to such an extent that the individual loops are hardly discernible. The base yarns, indicated by the reference numeral 16, may again be of any conventional type and of any conventional construction.

With reference to FIGURE 3 there is illustrated a cut pile, false chenille fabric having a pile 18 of elasticized yarns which is secured to a cloth backing 20 by con-

ventional stitching 22. The backing material may be of any conventional construction and may be formed of cotton, jute, or the like. Likewise, the yarn with which the pile is stitched to the backing may be of any type since its only purpose is to retain the pile in position.

With reference to FIGURE 4 there is illustrated a cut pile tufted fabric having a pile 24 of highly convoluted fibers inserted through a woven backing material 26. The backing material 26 may be of any conventional type and may suitably be cotton duck, burlap or the like. To give the fabric increased weight and to hold the pile yarns securely in position, the fabric is provided with a rubber latex coating indicated by the reference numeral 28.

The pile length according to this invention should be as a general rule from 20 to 80% longer than is conventionally employed for the same type of fabric. For example, for floor coverings a pile length of from $\frac{1}{2}$ to 1 inch generally gives excellent results and, under proper conditions, will contract so that in the completed fabric the pile height will be only from about $\frac{1}{4}$ to $\frac{5}{8}$ inch. For upholstery fabrics a pile length of from $\frac{1}{4}$ to $\frac{1}{2}$ inch will generally be found to be satisfactory and this generally results in a pile height of from about $\frac{1}{8}$ to $\frac{3}{8}$ inch in the finished fabric. The pile tuft density or number of pile tufts per unit area will, of course, depend upon the pile length and type of yarn used but as a general rule may suitably be appreciably less than that conventionally employed for a comparable fabric.

The chemical composition of the yarn employed for the formation of the pile in fabrics according to this invention may vary widely and generally includes all thermoplastic yarns, with specific examples being nylon yarns, polyester yarns such as sold under the trademark of Dacron and acrylic yarns such as those sold under the trademarks of Acrilan and Orlon.

The total denier of the yarn employed for the pile of fabrics according to this invention can vary within a very wide range depending upon the purpose for which the fabric is intended, the type of fabric and the appearance desired. For upholstery fabrics it may in some instances be desirable to employ a yarn for the pile having a total denier of no more than about 100, but for floor covering fabrics and the like it is frequently advantageous to employ yarns having total deniers as high as 5,000 to 10,000. Excellent results have been achieved in the weaving of both upholstery and floor covering fabrics by employing a 4-ply yarn with a total denier of 3200. The denier per filament may vary within wide limits and the factors determining the selection of a particular filament size include the purpose for which the fabric is intended and the appearance desired. As a general rule, best results are obtained in the weaving of upholstery fabrics if yarns are employed containing filaments of from 2 to 20 denier, and for floor covering, best results are generally obtained when employing yarns composed of filaments having a denier per filament of from about 8 to 60.

The twist in the yarns employed should as a general rule be very low since not only are low twist yarns more readily prepared by the above described methods of elasticizing but low twist yarns also open more efficiently and generally contract to a greater extent than do highly twisted yarns. If a multifilament singles yarn is to be employed in the formation of the pile, one should generally be used having no more than about 4 to 6 turns of twist per inch and if a multifilament plied yarn is to be employed, it should have no more than about 4 turns twist per inch in the component yarn and not more than about 6 turns per inch in the ply. An excellent material for both upholstery and floor covering fabrics comprises a plied yarn formed from 2 to 8 strands of zero twist yarn plied together for from about 1 to 4 turns per inch. A small amount of twist in the ply is especially advantageous in the formation of cut pile fabrics since the ply twist results in more clearly

defined patterns and an irregular pebble effect. If the yarns employed have zero turns twist in the ply and zero twist in the component yarns, the resulting pile has an even, wooly appearance which may be desirable in some instances but sharp pattern demarcation is difficult to achieve.

After the fabric is woven it should be given a heat treatment to fully develop the latent convolute forming crimp in the pile yarns but this generally does not require an additional step since the heat treatment can be combined with any one of several operations conventionally performed. For example, if the fabric is to be dyed, the hot dyebath serves to fully develop the yarns and a separate heating operation is not required. In instances where the fabric is not to be dyed, scoured or the like, it can be given a heat treatment suitable for developing the yarns by immersing the same in a hot water bath momentarily or by steaming the fabric for a few minutes in order to raise the temperature of the same to at least about 140° F. Beating or mechanically working the fabric more than is required for dyeing or the like is not only unnecessary, but is actually disadvantageous since it tends, in some instances, to cause a matting of the fibers in the pile.

The invention will be further illustrated by the following specific examples which have been selected to show the effect of varying ply twist, pile length, and pile tuft density. All yarns employed for the formation of the pile were "latently" crimped according to the procedure of United States application Serial Number 274,358, filed March 1, 1952.

Example I

A tufted pile fabric was prepared employing a cotton duck backing and 4-ply, 3200 denier, continuous filament, 15 denier per filament, nylon yarn for the pile. The pile yarn had zero twist in the component yarns and zero twist in the ply and the pile length was $\frac{3}{8}$ inch. The fabric was prepared with seven stitches per inch with $\frac{1}{4}$ inch between rows and the machine was equipped with knives to cut the pile loops at the time they were formed. The tufted fabric was steamed for one minute at atmospheric pressure and then dyed in a conventional manner to give a finished fabric having a pile height of about $\frac{3}{16}$ inch. The fabric has a wooly but somewhat pebbly appearance and has a negligible but interesting and novel sheen. This fabric is excellent for upholstery purposes.

Example II

Example I was repeated except that the pile length was $\frac{5}{8}$ inch as formed and the steaming step was omitted. The resulting fabric displays very little patterning, has a very wooly appearance and has a pile which is from about $\frac{1}{4}$ to $\frac{5}{16}$ inch in thickness after dyeing. This fabric is excellent for floor coverings when the base is given a latex rubber coating.

Example III

Example II was repeated except that the 4-ply yarn employed for formation of the pile had 2.6 turns per inch of twist in the ply. This fabric has a beautiful uneven pebbly surface with a pile thickness of about $\frac{1}{4}$ inch. The fabric displays absolutely no patterning so that it is practically impossible from a visual examination of the surface to determine in which direction the stitches were made. With a latex rubber coating on the underside it is excellent for floor coverings.

Example IV

Example I was repeated except that the knives were removed to result in the formation of a loop pile, the distance between rows of stitches was decreased to $\frac{5}{32}$ inch, the number of stitches per linear inch was increased to 8 and the fabric was washed in warm water at a temperature of about 150° F. in place of being steamed. The resulting fabric has a pile thickness of approximately $\frac{3}{16}$ inch and has a wooly appearance with a very low sheen. The surface of the fabric has a pebbly structure but the protrusions are evenly spaced and there is very little patterning.

Example V

Example I is repeated except that the 4-ply yarn employed in the formation of pile had 2.6 turns of twist in the ply, the pile was not cut, the length of the pile as formed was $\frac{3}{8}$ inch, the space between rows of stitches was $\frac{5}{32}$ inch and the number of stitches per inch was $8\frac{1}{2}$. The resulting fabric has an appearance similar to that prepared in Example IV above except that the tufts are not quite so voluminous and rows of tufts running lengthwise of the material are clearly discernable. The fabric would be excellent for an upholstery material.

Example VI

Example IV is repeated except that the pile length as formed was $\frac{3}{16}$ inch, the number of stitches per linear inch was increased to 10 and the fabric was steamed and dyed according to Example I. The resulting fabric has an appearance quite similar to that formed in Example V, with a pile thickness of approximately $\frac{1}{8}$ inch and displays distinct rows of pile tufts. This fabric is excellent for upholstery purposes.

This application is a continuation of copending application Serial Number 516,192, filed June 17, 1955, now abandoned.

That which is claimed is:

1. The method of forming a pile fabric comprising forming the pile of a pile fabric from multifilament thermoplastic yarn having latent coil forming undeveloped stresses therein urging the filaments to assume a crimped configuration, and developing by application of heat the latent stresses in said filaments in situ while said filaments are free to contract longitudinally and to move laterally apart under the influence of the then developed and patent coil formations.

2. The method according to claim 1 wherein the undeveloped filaments employed in forming said pile yarn have latent stresses therein urging said filaments to assume a coil form, the convolutions of which in developed patent crimp form are of varying size and phase and effect a lateral bulking and mutual pushing apart of said multifilament yarns.

3. The method according to claim 2 wherein said undeveloped filaments in cross-section show a differential degree of crystalline orientation from one edge of the cross-sectional area to another opposite edge.

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