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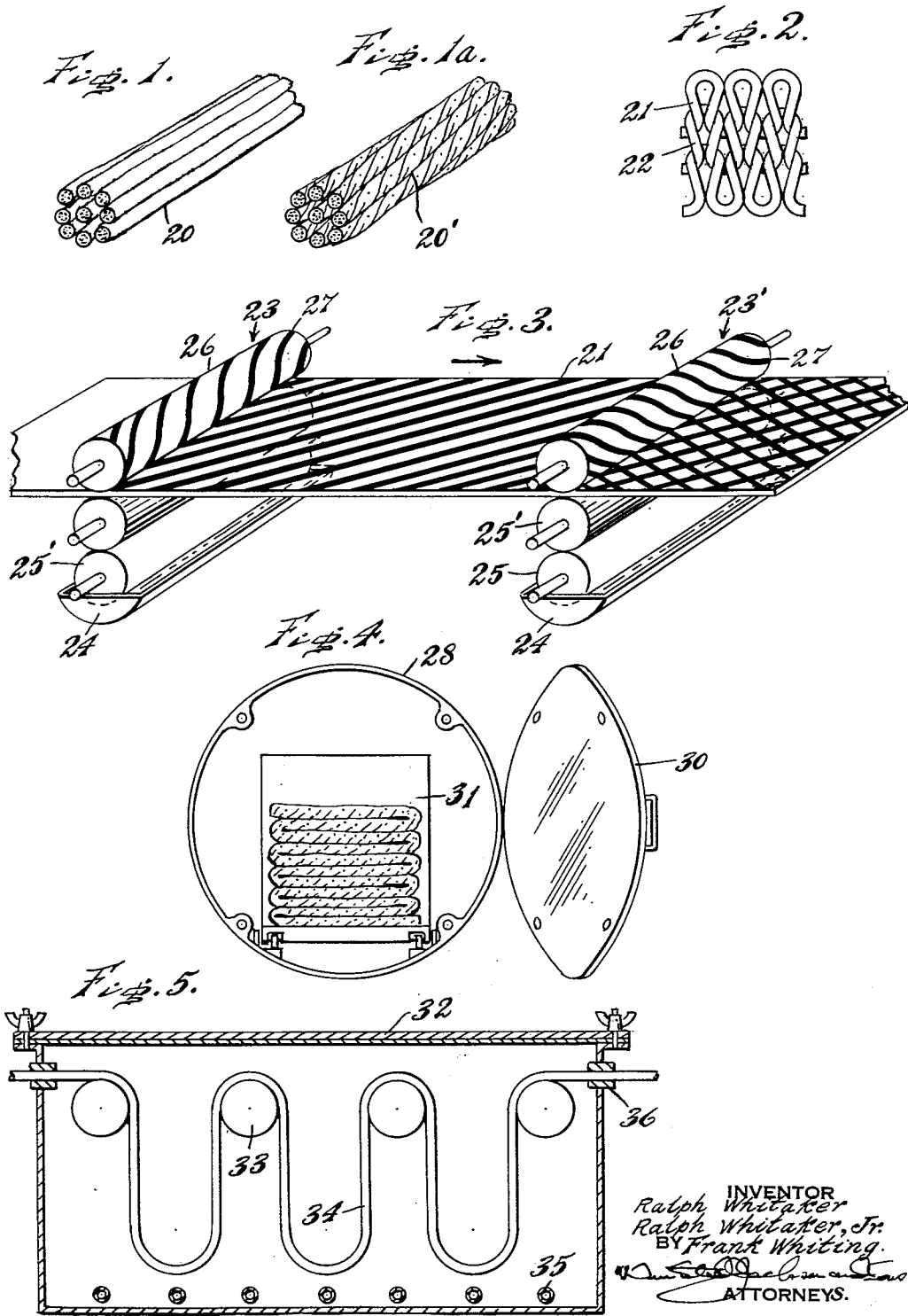
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3,012,303

PRODUCTION OF MULTICOLORED PILE FABRIC

Filed Dec. 24, 1959

2 Sheets-Sheet 1



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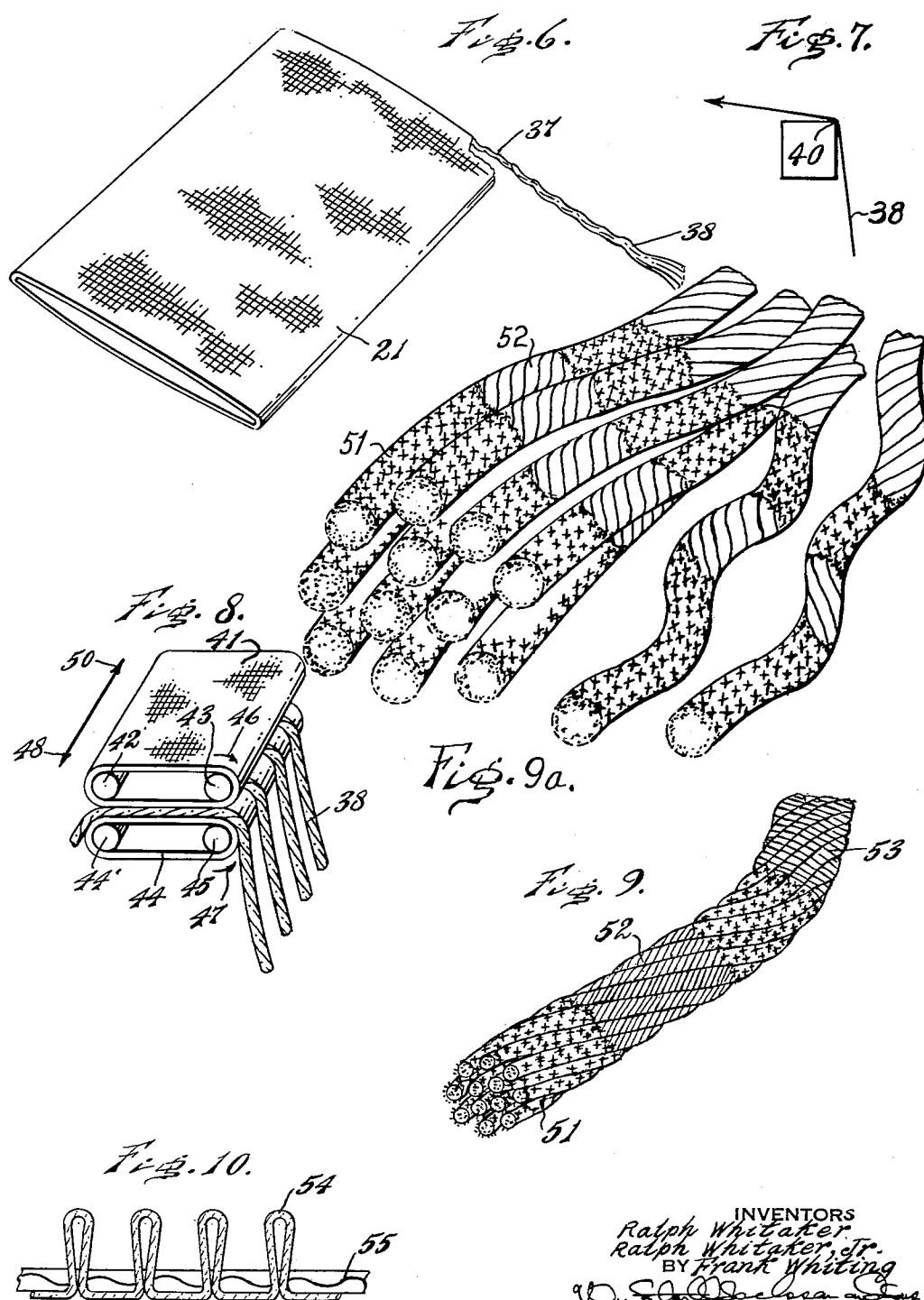
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2 Sheets-Sheet 2



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3,012,303

PRODUCTION OF MULTICOLORED PILE FABRIC
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Filed Dec. 24, 1959, Ser. No. 861,929
12 Claims. (Cl. 28—72)

The present invention relates to processes of producing multicolored yarn from continuous filament or spun staple thermoplastic textile fibers, for use as the face yarn of carpets and upholstery fabrics, including pile fabrics. Carpets and upholstery fabrics are referred to herein as house furnishing fabrics.

A purpose of the invention is to knit multi-filament continuous filament or staple fiber thermoplastic synthetic yarn into a knitted prefabric, to apply to the knitted prefabric stripes or other localized areas of dye of various colors, to set the dyestuff on the knitted prefabric and set the loops at elevated temperature, to unravel the knitted prefabric, to open and fluff the yarn, to twist the yarn, and to use the yarn as the face yarn of a carpet or upholstery fabric.

A further purpose is to heat-set the knitted prefabric at elevated temperature so as to produce a more desirable texture in the yarn and final carpet or upholstery fabric.

A further purpose is to eliminate streaks in a carpet or upholstery fabric later to be made, by knitting face yarn into a prefabric, applying stripes or other localized areas of dye of various colors across the prefabric either in a direction angularly disposed to the direction of yarn in the prefabric or in the direction of the yarn in the prefabric, to unravel the prefabric so as to produce yarn color areas distributed along the yarn, and then to use this yarn as the face yarn of a carpet or upholstery fabric.

A further purpose after applying stripes or other localized areas of dye to the prefabric, is to heat-set the prefabric including the loops, open up the yarn so as to distribute the color more desirably at points where the stripes or areas adjoin, and then twist the yarn.

A further purpose is to apply stripes or other localized areas of color to a knitted prefabric either at an angle to the direction of yarn in the prefabric, or in the direction of the yarn, to heat-set the knitted prefabric including the loops before or after the application of the stripes or areas, and to then unravel the prefabric, fluff out the continuous filaments of the yarn and twist the yarn.

A further purpose is to apply localized areas of color to the knitted prefabric, of such location and size that when the knitted prefabric is unravelled and the yarn is opened and twisted, and then formed into a finished carpet or upholstery fabric as the face yarn thereof, a pattern will be produced on the face of the finished fabric.

A further purpose is to obtain the advantage of greater color fastness by using faster dyestuffs which is possible by virtue of the process of the invention.

A further purpose is to apply stripes or dots or any other suitable configuration of color to a knitted prefabric, so that upon unravelling the prefabric and forming the yarn into the face of a carpet or upholstery fabric, the resulting fabric will exhibit a markedly reduced tendency toward streaks or the formation of any other undesirable pattern outline.

A further purpose is to produce a carpet or upholstery fabric which has a more attractive and novel random dispersion of color on the face of the fabric.

Further purposes appear in the specification and in the claims.

In the drawings we have chosen to illustrate several different mechanisms which may be used in carrying out the process of the invention.

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FIGURE 1 is a fragmentary perspective of untwisted yarn which may be used in the present process.

FIGURE 1a is a fragmentary perspective of twisted yarn which may be employed in the process of the invention.

FIGURE 2 is a face view of a knitted flat prefabric illustrating a knitting step which may be employed in the present invention.

FIGURE 3 is a fragmentary perspective showing the printing of stripes or other localized areas of color on the prefabric in the present invention.

FIGURE 4 is a diagrammatic front elevation of an autoclave showing heat-setting and dye-setting according to the invention.

FIGURE 5 is a diagrammatic central vertical section of a continuous heat-setting and dye-setting vessel used in the present invention.

FIGURE 6 is a perspective illustrating the unraveling of the prefabric in the present invention.

FIGURE 7 is a diagrammatic elevation illustrating the pulling of the unravelled yarn over a corner to fluff it.

FIGURE 8 is a fragmentary perspective showing a rubbing motion applied to the unravelled yarn to fluff it.

FIGURE 9 is a fragmentary perspective view illustrating a form of the unravelled yarn prior to fluffing.

FIGURE 9a is a view corresponding to FIGURE 9 and representing the yarn in an opened up or fluffed condition of the strands.

FIGURE 10 is a longitudinal section of a tufted pile carpet fabric using the yarn of the invention.

Describing in illustration but not in limitation and referring to the drawings:

Difficulty with streaks in the faces of carpets and the like has been encountered for many years. With the use of face yarn consisting of spun nylon and nylon continuous filament, the frequency of occurrence of streaks has been greatly increased. This condition has been exhibited not only in solid shade carpets, but also in carpets having multiple ply yarn of different colors. While the tendency to streak has been serious in woven pile fabrics such as velvet carpet, the difficulty has been much more pronounced in tufted pile carpets because of the construction and prominence of the face yarn.

The recent production of texturized or bulked filament yarns has further increased the seriousness of the problem.

The invention makes it possible to produce improved coloring and pattern effects which have not been readily obtainable in the prior art, and assists in giving better control of coloring effects, and in softening the gradations and zones of demarcation between different colored areas, so that variations in color application will not be noticeable.

The present invention is also concerned with the improvement of face yarn for carpets, rugs, upholstery fabrics and the like, especially pile fabrics, to improve the yarn construction and particularly to reduce the difficulty encountered on account of streaks.

In accordance with the present invention, the yarn which is to be used as pile yarn or the like in carpets, rugs and upholstery fabrics is first preformed into a fabric. To this fabric stripes or other localized areas of dye are applied preferably in a direction at an angle to the direction of yarn travel in the fabric, but permissibly in the direction of yarn travel. The term "stripes" is intended to include strips, zones and splotches. The dye is then set. The prefabric is then unravelled, and dye is thus provided on suitable lengths of the yarn which will in many cases be so short that the effect looks like nubs of variant or random coloring. The principles of the invention can also be applied by coloring different areas of the finished fabric according to a predetermined pattern, so that the lengths of yarn when the preformed fabric is unravelled will be colored in a pre-

determined manner to produce a pattern in the final carpet or upholstery.

Any desired pattern contour on the face of the finished fabric can be produced in this way.

The stripes or other localized areas of dye are applied to the prefabric when the prefabric is united together, and in the preferred embodiment of the invention loops or the like in the prefabric are heat-set so as to form kinks. Subsequently to the dyeing of the stripes or other localized areas of the prefabric and also the heat-setting, the prefabric is unravelled and then the yarn is opened up or fluffed. This causes the bulk of the yarn to increase greatly, distributes the colored zones over a wider area, and due to the fact that the kinks in the continuous filament prevent the individual filaments from closely adjoining one another, the lines of demarcation between the areas of different color along the yarn are blended or softened by the opening up of the yarn.

Further softening or blending of color is obtained by applying one color over another at the same point.

When the yarn is later twisted, this has the effect of avoiding observation of any slight defects in registry of the original stripes or other localized areas of color.

It also produces an extremely lofty yarn, which is less subject to variation in size, which has better face yarn coverage, improved optical properties and a soft feel. The invention may be applied to yarn previously textured or bulked by some other process.

Considering now the invention in detail, we employ in making yarn according to the present invention multi-filament continuous filament thermoplastic synthetic yarn. Nylon (linear polyamide) of any of the types is suitable. Other thermoplastic synthetic fibers may be used such as acrylic (Orlon, Acrilan) and modified acrylic. The yarn should be of a size of 50 to 10,000 denier in the yarn, preferably 500 to 4500 denier. The number of filaments will be at least 10 and preferably at least 100. The individual continuous filaments are of a size between 1.5 and 30 denier and preferably between 1.5 and 22 denier. In the case of yarn from synthetic staple fiber, similar fibers will be used.

The original yarn may have a twist of say 0 to 6 turns per inch, preferably $\frac{1}{2}$ to 3 turns per inch, or it may be effective without twist.

The yarn 20 in FIGURE 1 is without twist while the yarn 20' in FIGURE 1a has a twist as above described.

The yarn above referred to is first knitted into a knitted prefabric 21 having loops 22 as shown in FIGURE 2 which illustrates a weft knitted flat fabric, in which each loop 22 in the body of the fabric is held at both ends so as to obtain control of the loop with no looseness of the loop. When the fabric is later heat-set, this tends to provide tighter control of the curl or kink, and avoids the possibility of flat spots which might otherwise occur. The knitting is conducted on a flat or circular knitting machine to produce the fabric shown in FIGURE 2.

It is not important in the invention whether the prefabric is flat or ribbed.

It will be evident that the control of the tightness of the curl and therefore of the extent of kinking can be closely regulated by controlling the tension in the knitting machine, and the number of stitches per inch, the gauge and number of stitches suitably being made finer when the total denier of the yarn is finer, and also when the individual filament size is fine.

After the fabric is knitted, according to one embodiment of the invention, stripes or other localized areas of different colors are applied across the fabric preferably at an angle to the direction in which the yarn extends, but permissibly in the direction in which the yarn extends.

In FIGURE 3 we show fabric 21 which moves in the direction of the arrow, through a plurality of printing or padding stations 23 and 23', each applying a different

color. As shown each Vigoureux printer includes a dye trough 24, a pick up roll 25 entering the trough, a take off roll 25' engaging the top of the pick up roll and the bottom of the fabric and a printing roll 26 above the fabric having projections 27 which follow a certain contour and determine the locations of application of the dye to the fabric by pressing against the resilient take off roll.

The individual stripes or other localized areas obtained may or may not be adjoining, and if desired there can be natural areas left unprinted between the individual stripes (splotches).

While the stripes (splotches) have been shown as being printed or padded, it will be evident that the color can be applied by spraying or splashing, either by hand or by suitable equipment.

The question of whether the stripes (splotches) are of the same size or varying sizes will depend upon whether or not a pattern is being applied and whether or not it is desired to have the colors equally distributed.

It will of course be evident that stripes (splotches) can be superimposed if desired and the color produced in a certain area can be the mixed result of superimposing two or three stripes (splotches) of dye.

A very convenient manner of applying the dye is by the Vigoureux type of printing machine or the warp intaglio printing machine or the air brush.

While it is preferred to apply the stripes (splotches) of color prior to the heat-setting, it will be evident that if desired the stripes (splotches) of color can be applied independently of the heat-setting and subsequent thereto, and in that case the dye of the stripes (splotches) can be fixed by any suitable means if required.

The knitted prefabric, preferably after application of the stripes of color, is next heat-set. For this purpose the prefabric is conveniently placed in an autoclave 28 as shown in FIGURE 4. The autoclave has a pressure-tight cover 30, is suitably heated as by superheated steam introduced at the interior, and has a suitable support at 31 for the prefabric. The temperature in the autoclave will suitably be 180 to 270° F. and the time at temperature should be between 1 and 30 minutes. The heat-setting causes the nylon or other synthetic fiber to form curls or kinks due to the loops produced in knitting, accompanied by pronounced shrinkage.

While an autoclave can be used as shown in FIGURE 4, it will be preferable in many cases to employ continuous heat-setting in the pressure chamber 32 as shown in FIGURE 5. In this case, the fabric passes through the pressure chamber on driven rolls 33 which produce free stretches 34. Steam admitted through pipes 35 maintains a temperature of 180 to 270° F. Suitable vestibules may be employed as suggested diagrammatically by the seals 36.

After completion of the heat-setting and of the application of the stripes (splotches) of dye, and fixing of the dye if this is accomplished after heat-setting, and normal scouring and drying, the prefabric is unravelled as shown at 37 in FIGURE 6.

The unravelled yarn 38 with permanent kinks or curls introduced into it is next opened up by fluffing. It is important to disarrange the loops so that the loops on individual continuous filaments or fibers will not be side by side. This is conveniently accomplished as shown in FIGURE 7 by running the kinked yarn 38 over a corner 40 or preferably over a series of corners. The corners suitably should not be sharp enough to cut the edge of the yarn.

Opening up can be accomplished particularly on untwisted yarn by rubbing the yarn transverse to its axis as shown in FIGURE 8. This figure illustrates the rubbing mechanism of a woolen card, including an upper belt 41 passing over front and back pulleys 42 and 43 and a lower belt 44 passing over front and back pulleys 44' and 45. The belts progress around their pulleys in the direction

of the arrows 46 and 47. The belts also oppositely oscillate axially in the directions indicated by the arrows 48 and 50 as well known in woolen card rubbing mechanism. Whether a corner or a rubbing motion is used, the effect is to open up the yarn to at least three times the initial diameter. The color becomes widely distributed laterally from the standpoint of improved coverage, and the zones of demarcation of color are graduated since there are different orientations of different filaments laterally and also longitudinally to a slight degree.

The yarn is next twisted preferably to achieve a twist of from zero to six turns per inch, preferably one-half to three turns per inch in the single.

The yarn according to the invention can then be plied with other yarn ends of similar or different color. In some cases the twist in the ply may be heat-set if desired.

The final yarn in accordance with the invention is wound on cones or tubes, and then will suitably be used for producing face yarn or pile yarn for carpets, rugs, upholstery fabrics and the like.

Example I

A yarn without twist having a size of 2100 denier in the yarn, consisting of continuous filament nylon (type 6) of 15 denier was knitted on a circular knitting machine having 10 gauge butt needles, 54 needles in the circle, 9 stitches per inch in width and 10 courses per inch in length, to produce a 4 inch diameter cylinder.

The resulting prefabric was a tube, since a circular knitting machine was used.

The knitted tube was printed with diagonal stripes of green and brown, the stripes running at a slight angle and crossing the tube about every foot.

The brown printing or dyeing composition was as follows:

Irgalan Brown 2RL (Prototype Acid Brown 45)	
----- grams per liter--	41.7
Ethylene glycol----- c.c. per liter--	33.3
Gum thickener (Keltex)----- grams per liter--	16.7
Water-----	Balance

31 liters of the brown printing formula was used to pad 156 pounds of the nylon knitted tube.

A green printing or dyeing formula was used as follows:

Lanasy Brilliant Green BL Pat. (Prototype Acid Green 40)	
----- grams per liter--	8.3
Ethylene glycol----- c.c. per liter--	33.3
Gum thickener (Keltex)----- grams per liter--	16.7
Water-----	Balance

21 liters of the green strip printing composition was used for 156 pounds of the nylon tube.

The fabric thus printed was placed in an autoclave as in FIGURE 4, and the temperature held at 210° F. for 10 minutes.

The prefabric was then removed, scoured, dried and unravelled. The yarn was run over three corners in succession, twisted to one turn per inch, and plied into three-ply yarn, twisted one turn per inch in the ply.

The yarn was then made into a tufted fabric having uncut pile loops on the face. An extremely beautiful variegated effect was obtained showing pile loops in pronounced curls of different colors, some brown, some green, some white and some involving various blends.

Example II

The procedure of Example I was carried out, except that the knitting machine was 12 gauge, 108 needles in a 4 1/4 inch diameter cylinder. The results were similar to those of Example I.

Example III

A nylon (type 6) yarn of 4200 denier, consisting of continuous filament of 15 denier per filament having a twist of one turn per inch was knitted into a weft knitted prefabric as set forth above.

The prefabric was subjected to padding with the first composition of Example I, and then set by steam in an autoclave held at 220° F. for 10 minutes. The prefabric was then printed with stripes of brown dye having the composition set forth in Example I.

The stripes were run at approximately 45° diagonally across the prefabric in one direction and then at 45° across the prefabric in the opposite direction, there being a space between the stripes of about equal width to the width of the stripes.

The dye was fixed by steaming.

The prefabric was unravelled and then the yarn was opened up by running it over a series of three corners in succession, after which it was twisted in the opposite direction to the original twist until it had a twist of one turn per inch. The yarn was then plied into three plies and tufted to form cut and also loop tufted pile fabrics for carpets.

The resulting fabrics show areas of light green and areas of brown and areas in which there is a demarcation of light green and brown with a high degree of loft and excellent coverage. The yarn of the invention when applied in fabrics is found to give a life of 60 hours fastness under the fadometer.

The invention can be used to produce mottled, marbelized and variegated effects as well as pattern effects.

The colored yarn of FIGURE 9 which is an example of the unravelled yarn of the prefabric has one zone along its length 51 of one color and another zone 52 of another color. The next zone 53 may be of a third color or may be a repetition of the zone 51 as desired. As will be noted in FIGURE 9a, when this yarn is opened up the color becomes distributed laterally and the zones of demarcation of the several strands are graduated since there are different orientations of different strands laterally and the colors are even shifted longitudinally of the yarn from strand to strand. Heat setting of the yarn in the prefabric introduces kinks to the yarn and its strands and these kinks enhance the color distribution when the unravelled yarn is given the opening up treatment.

The finished yarn of the invention is made into a carpet fabric, as shown in FIGURE 10, which may for example consist of pile loops 54 tufted through a backing 55.

Good results have been obtained following the techniques of the examples with 3700 denier nylon yarn, 15 denier per filament, and with 1300 denier nylon yarn, 15 denier per filament. The closeness of knitting in the latter case was 54 needles per inch and in the former case 27 needles per inch, in both cases 10 gauge.

Good results are also obtained following the procedure of the examples with spun staple fiber.

Various localized dyes may be used, including Neutral Premetalized Dyes, Acid Premetalized Dyes, and Pigment Textile Printing Colors.

Suitable examples of dyes for use in the examples are:

Lanasy Yellow GL (Prototype Acid Yellow 114)	
Cibalan Yellow FGL (Prototype 713)	
Capracyl Orange R (Prototype Acid Orange 60)	
Cibalan Orange RLN (Prototype Acid Orange 86)	
Cibalan Brown BL (Prototype Acid Brown 19)	
Capracyl Brown RD (Prototype Acid Brown 29)	
Capracyl Red B (Prototype Acid Red 182)	
Lanasy Red 2GL Pat. (Prototype Acid Red 216)	
Cibalan Bordeaux GRL (Prototype Acid Red 213)	
Lanasy Brilliant Blue GL (Prototype Acid Blue 127)	
Irgalan Grey BL (Prototype Acid Black 58)	
Lanasy Brilliant Green BL Pat. (Prototype Acid Green 40)	
Capracyl Yellow 3RD (Prototype Acid Orange 64)	
Irgalan Brown 2RL (Prototype Acid Brown 45)	
Lanasy Brown RL P.A.F. (Prototype Acid Brown 28)	
Capracyl Blue G (Prototype Acid Blue 165)	
Lanasy Bordeaux RL Pat. (Prototype Acid Red 217)	

In view of our invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of our invention without copying the process shown, and we, therefore, claims all such insofar as they fall within the reasonable spirit and scope of our claims.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:

1. The process of making a house furnishing fabric, which comprises producing a prefabric from face yarn, dyeing localized areas of the prefabric so that different lengths of the yarn will have different colors when the prefabric is unravelled, unravelling the prefabric, opening up the yarn to re-orient the fibers in the yarn and distribute the color, and forming a fabric of the opened up yarn having the yarn and its colors exposed at the face of said fabric.

2. The process of claim 1, which comprises superimposing one dye on another in areas of the prefabric.

3. The process of claim 1, which comprises twisting the opened up yarn to modify the color aspect of the yarn.

4. The process of claim 1, in which the yarn is continuous filament yarn.

5. The process of claim 1, in which the fiber of the yarn is staple fiber.

6. The process of making a house furnishing fabric, which comprises knitting a prefabric from face yarn, dyeing localized areas of the prefabric so that different lengths of the yarn will have different colors when the prefabric is unravelled and setting the prefabric to form kinks in the yarn, unravelling the prefabric, opening up the kinked yarn to re-orient the fibers in the yarn and distribute the color, and forming a fabric of the opened up yarn having the yarn and its colors exposed at the face of said fabric.

7. The process of making a house furnishing fabric, which comprises knitting into a prefabric yarn having a size between 50 and 10,000 denier of multifilament thermoplastic synthetic fiber having a size of the fiber between

1.5 and 30 denier, applying to the prefabric localized areas of dye so that different lengths of the yarn will be of a different color when unravelled and heat-setting the fabric at a temperature between 150° F. and 250° F. to form kinks in the yarn, unravelling the fabric, opening up the kinked yarn to at least about three times its initial diameter and twisting the yarn to re-orient the fibers in the yarn and distribute the color, and forming a fabric of the opened up yarn having the yarn and its colors exposed at the face of said fabric.

8. The process of claim 7, in which the kinked yarn is run over a corner to open up the yarn after unravelling and prior to twisting.

9. The process of claim 7, which comprises rubbing the yarn in a direction transverse to the axis to open up the yarn after unraveling and prior to twisting.

10. The process of making a house furnishing fabric, which comprises knitting a prefabric from face yarn, dyeing localized areas of the prefabric so that different lengths of the yarn will have different colors when the prefabric is unravelled and setting the prefabric to form kinks in the yarn, unravelling the prefabric, opening up the kinked yarn to re-orient the fibers in the yarn and distribute the color, and forming a pile on a backing by tufting said opened up yarn through said backing and exposing said yarn at the pile face.

11. The process of claim 10, in which the color on the yarn is in short sections along the length of the yarn and simulates a nub effect in the pile.

12. The process of claim 10, in which the pile face of the fabric produced includes uncut loops of said kinked yarn.

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"New Nylon Carpet Textures," by I. R. Needle and M. Romer, from Modern Textiles Magazine, October 1958, pages 55 to 58. (Copy in Division 21.)

Disclaimer

3,012,303.—*Ralph Whitaker*, Philadelphia, Pa. *Ralph Whitaker, Jr.*, Raleigh, and *Frank E. Whiting*, Garner, N.C. PRODUCTION OF MULTI-COLORED PILE FABRIC. Patent dated Dec. 12, 1961. Disclaimer filed May 5, 1972, by the assignee, *Fred Whitaker Company*.

Hereby enters this disclaimer to claim 5 of said patent.

[*Official Gazette January 2, 1973.*]