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SPOT DYEING PROCESS AND APPARATUS

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Introduction and Brief Description

This invention relates to a method and apparatus for applying substances, such as dyes, to strands, such as textile yarns, in spots randomly arranged along the length of the strand, and it is an object of this invention to provide an improved method and apparatus of this kind.

Yarns dyed by the method of this invention create a pleasing effect which may be used as the pile of rugs.

According to this invention, the strand to be treated should be bent upon itself and packed in a column or layer of substantial thickness. In the preferred embodiment the bent and packed strand is the crimped bundle created by a modified version of a yarn-crimping apparatus of the type shown in United States Letters Patent Nos. 2,311,174 and 2,747,233. The apparatus comprises an elongated yarn crimping chamber of the stuffer-box into which two cooperating rolls introduce yarn to bend the yarn upon itself and to compress as it advances through the chamber under the pressure necessary to overcome the friction of the walls of the chamber on the yarn and to overcome any back pressure existing at the exit from the chamber.

When the strand leaves the chamber it is advanced while still bent and under pressure toward a member to contact a surface thereof which carries the substance to be applied to the strand. Preferably the member contacted is a rotatable generally cylindrical roll with its axis normal to the direction of the strand advance and arranged so that the force exerted on the roll by the advancing strand creates a turning moment in the roll about its axis.

Only part of each succeeding segment of the bent and packed strand can contact the roll surface, and the remainder is allowed to advance past the roll at the same time the part in contact with the surface is allowed to escape from that contact. Consequently given segments of the strand will have portions which received a transferred substance from the roll surface as well as other portions which did not. Conveniently the roll partially blocks the exit from a crimping chamber to provide a restricted passage through which the strand escapes past the roll to achieve this partial transfer as the roll rotates.

Another object of this invention is to provide a novel method for both spot dyeing and crimping a thermoplastic yarn. This object is achieved by crimping a thermoplastic yarn and applying dye thereto randomly in the manner heretofore described, and finally heating the yarn to heat set the crimp in it as well as to set the dye in the spots of dye applied to it.

For a better understanding of the nature of this invention, reference should be had to the following detailed description of specific embodiments thereof when read in conjunction with the accompanying drawing forming a part hereof wherein:

The Drawing

FIG. 1 is a face view of a stuffer-box yarn crimper which is used as the yarn bending and packing apparatus;

FIG. 2 is an elevation of the right side of the lower part of the apparatus shown in FIG. 1 with the applicator adder thereto;

FIG. 3 is a cross-section along the line 3—3 through FIG. 2;

FIG. 4 is a development view of the liquid supply font of the applicator, and

Detailed Description

A stand 10 carries two rolls 11, 12 rotatably driven to advance the strand downwardly in FIG. 1 and into the crimping chamber. Strand 13 is compressed longitudinally by the action of rolls 11, 12; it is bent upon itself, and it is packed in the elongated crimping chamber. As best seen in FIG. 3, the crimping chamber frame has a back plate 14 and face plate 17 which are parallel to each other, and two parallel side plates 15, 16 defining crimping chamber 18 that is generally rectangular in horizontal cross-section. Crimping chambers of this type sometimes have a hinged lower section of the face plate weighted to enter the lower end of the chamber to create added resistance to passage of the strand through the elongated chamber and consequently to create added crimping pressure, but the device shown in the drawing has no such hinged section. The chamber shown is several inches long, and the friction developed at the walls of the elongated chamber is sufficient to create the necessary crimping pressure. The length of the column of strand 13 in chamber 18 obviously is many times the strand's thickness.

The structure thus far described is old in principle, and is substantially the same and functions in the same way as the apparatus disclosed in United States Letters Patent Nos. 2,311,174 and 2,747,233.

The treating material, which is preferably a liquid, is held in a font 19 which is shown in the development view of FIG. 4, and which is shown assembled and fixed to the back plate 14 of the crimping chamber frame in FIGS. 2 and 3. A clamp block 20 grips, and is vertically slidable on, the rail section 21 of back plate 14. The side plates 22, 23 of font 19 are riveted to the clamp 20, and a set screw 24 passes through a threaded hole in clamp 20 to frictionally engage the back of rail section 21. To raise or lower font 19, set screw 24 is loosened, clamp 20 is slid vertically and set screw 24 is re-tightened to fix the applicator in its new position.

Two transversely extending and axially aligned screws 25, 26 are threaded through side plates 22, 23 of font 19 and are locked by lock nuts 30, 31 respectively which fix the distance between the inner ends of these screws. Screws 25, 26 have sixty degree points adapted to fit loosely in conical central holes in the sides of a generally cylindrical roll 27 so that roll 27 is rotatably supported on the screws.

It will be apparent from the drawings and the description thus far that the axis of roll 27 is normal to the direction of strand advance through the crimping chamber 18. Attention is directed to FIG. 2 where the radius of the outermost surface of roll 27 is shown approximately equal to the cross-sectional dimension from back plate to face plate of chamber 18. It also appears from the figure that in this embodiment the axis of roll 27 is positioned slightly to the rear (to the right as seen in FIG. 2) of that surface 32 of back plate 14 which defines one side of crimping chamber 18, and the upper surface of roll 27 is positioned substantially tangent to the bottom plane of crimping chamber 18. Consequently a restricted passage, one of whose dimensions is designated by the character "X" in FIG. 2, is provided for escape of the strand past roll 27. The dimension "X" as used herein is measured on the line joining the lower rear corner 35 of face plate 17 and the axis of roll 27 and is the distance between corner 35 and the radially outermost element of the surface of roll 27. From FIG. 3 it will appear roll 27 is longer than the cross-sectional dimension of chamber 18 from side plate to side plate.

Two additional transversely extending and axially aligned screws 33, 34 are threaded through side plate 23,
22 of font 19 and are locked by lock nuts 39, 49 respectively which fix the distance between the inner ends of these screws. Screws 33, 34 have sixty degree points adapted to fit loosely in conical central holes in the sides of a large transfer roll 28, so roll 28 is rotatably supported on these screws. The axis of roll 28 is parallel to the axis of roll 27, and the former is positioned to run in the liquid in font 19 and simultaneously to contact the outer surface of roll 27 (which is out of that liquid), so roll 28 picks up liquid from the font and transfers it to roll 27. A metal supply tube 29 is provided so a flexible hose (not shown) may be connected thereto to introduce material from a supply into font 19.

The bottom of tube 29 is spaced a short distance from the bottom of the font, and therefore it will allow liquid to accumulate in the font until the end of the tube is sealed off. Thus tube 29 acts as a constant level device in much the same manner that a drinking fountain for poultry operates. The major supply of liquid is stored in a closed bottle (not shown), connected to the other end of the hose on tube 29. As the liquid runs out of the bottle by gravity, a vacuum is created which prevents additional liquid from leaving the bottle. This vacuum can be relieved by air bubbles entering through the bottom of the supply tube 29 when the liquid level falls beneath the level of the bottom of tube 29. As best appears in FIGS. 2 and 3 roll 27 partially blocks the exit from crimping chamber 18. The surface of roll 27 is rotatable toward face plate 17 (counterclockwise in FIG. 2), so the strand to be treated passes through the restricted passage between corner 35 and the surface of roll 27 as the strand escapes past the surface of that roll as it rotates.

Roll 28 is shown as a stainless steel roll with a knurled outer surface to facilitate liquid pick-up and transfer. Roll 27 has a fluted rubber cover so its outer surface has a gear toothed configuration. If desired roll 27 may be a knurled stainless steel roll similar to roll 28, or it may be covered with a porous substance such as porous rubber, wicking or the like.

**Operation**

To operate the device, a strand 13 is crimped by being stuffed into restricted crimping chamber 18 under pressure by rolls 11 and 12, and the strand is moved through this crimping chamber and forced out the bottom as additional strand is stuffed in at the top. Strand 13 is in a randomly crimped state as it is ejected from the crimping chamber. While it is being forced out of the crimping chamber it is forced against the surface of roll 27. The pressure on strand 13 at the time it contacts roll 27 is less than that to which it was subjected in crimping chamber 18, and normal resiliency of the strand causes it to "open up" at this point in an effort to reduce the pressure, but the strand is still under some pressure from crimping chamber 18.

Since the strand 13 is randomly crimped, randomly spaced spots of the material in font 19 are transferred from the surface of roll 27 to the strand. Because of the bent and packed condition of the strand which advances toward roll 27 in a continuous column, only part of each succeeding segment of the strand can contact the surface of roll 27. The pressure on the strand as it touches roll 27 creates a turning moment about the roll's axis due to the off-set arrangement of the roll. As the roll 27 rotates (counterclockwise in FIG. 2) past corner 35 the direction of advance of the column is altered at least in part, the part of strand 13 in contact with the surface of roll 27 is allowed to escape from that contact and at the same time other parts of the yarn escape past roll 27 through the restricted exit passage without actually contacting roll 27. Consequently, given segments of the strand will have portions which receive a transferred substance from the roll surface and other portions that did not receive this substance. As roll 27 rotates, it in turn trans-
to treat yarns made of acetate rayon fibers, and in that case a setting temperature of 230°F. would be used.

It will be apparent from the foregoing description that various substances other than dyes can be applied to strands using the method and apparatus of this invention. For example, in place of a dye, a resist could be applied to a yarn in randomly spaced spots and the yarn subsequently overdyed. Thus a yarn of the type used in specimens A and B could be processed with a solubilized, sulfur-containing, phenol condensate type resist in a neutral bath under the normal dyeing conditions for that dye class. The spots where the resist was applied would be white or tan, and the remainder of the yarn would be brown.

Having thus described my invention, what I claim and desire to protect by Letters Patent are:

1. A method of applying a substance to a strand which comprises
   - providing a strand that has been bent on itself and packed in a column several times the strand's thickness,
   - advancing said column in the direction of its length and toward a member having a rotatable surface carrying the substance to be applied to the strand,
   - contacting such surface successively with spaced segments of the strand while under pressure in said column and thereafter allowing said segments to escape from contact with such surface,
   - allowing the portions of the advancing strand intervening between said spaced segments to advance past said surface out of contact therewith, and continuing to so advance succeeding segments of said strand.

2. A method of applying a substance to a yarn which comprises
   - providing a yarn that has been bent on itself and packed in a column several times the yarn's thickness,
   - advancing said column in the direction of its length and toward a member having a rotatable surface carrying the substance to be applied to the yarn,
   - contacting such surface successively with spaced segments of the yarn while under pressure in said column and thereafter allowing said segments to escape from contact with such surface as it rotates,
   - allowing the portions of the advancing yarn intervening between said spaced segments to advance past said surface out of contact therewith as it rotates, and continuing to so advance succeeding segments of said yarn.

3. A method of spot-dyeing yarn which comprises
   - providing a yarn that has been bent on itself and packed in a column several times the yarn's thickness,
   - advancing said column in the direction of its length and toward a rotatable generally cylindrical roll carrying the dye on its outer surface,
   - contacting such surface successively with spaced segments of the yarn while under pressure in said column and thereafter allowing said segments to escape from contact with such surface as the roll rotates,
   - allowing the portions of the advancing yarn intervening between said spaced segments to advance past said surface out of contact therewith as the roll rotates, and continuing to so advance succeeding segments of said yarn.

4. A method of spot-dyeing yarn which comprises continuously bending a thermoplastic yarn upon itself and packing it in a column several times the yarn's thickness, advancing said column in the direction of its length and toward a rotatable generally cylindrical roll carrying the dye on its outer surface, contacting such surface successively with spaced segments of the yarn while under pressure in said column and thereafter allowing said segments to escape from contact with such surface as the roll rotates, allowing the portions of the advancing yarn intervening between said spaced segments to advance past said surface out of contact therewith as the roll rotates, and continuing to so advance succeeding segments of said yarn.

5. A method in accordance with claim 4 including the step of finally heating the treated yarn to a temperature sufficient to set the crimp therein and the dye thereon.

6. A method of spot-dyeing yarn which comprises continuously bending a yarn upon itself and packing it in a column in an elongated crimping chamber, advancing said column in the direction of its length through said crimping chamber and toward a rotatable generally cylindrical roll, applying dye to the outer surface of said roll to be transferred therefrom to said yarn, contacting such dye carrying surface successively with spaced segments of the yarn while under pressure in said column and thereafter allowing said segments to escape from contact with such surface as the roll rotates, allowing the portions of the advancing yarn intervening between said spaced segments to advance past said surface out of contact therewith as the roll rotates, and continuing to so advance succeeding segments of said yarn.

7. A method of spot-dyeing yarn which comprises continuously bending a yarn upon itself and packing it in a column in an elongated crimping chamber, advancing said column in the direction of its length through said crimping chamber and toward a rotatable generally cylindrical roll partially blocking the exit from said chamber, applying dye to the outer surface of said roll to be transferred therefrom to said yarn, contacting such dye carrying surface successively with spaced segments of the yarn while under pressure in said column, altering the direction of yarn advance and allowing said segments to escape from contact with such surface as the roll rotates, allowing the portions of the advancing yarn intervening between said spaced segments to advance past said surface on said altered course out of contact with the surface as the roll rotates, and continuing to so advance succeeding segments of said yarn.

8. Apparatus for applying a substance to a strand which comprises
   - a member having a surface carrying said substance,
   - means for advancing a strand toward said member into contact with said surface while said strand is bent on itself and packed in a column several times the strand thickness,
   - means for maintaining pressure on said strand while it is in contact with said surface,
   - means defining in conjunction with said surface an escape passage through which said strand escapes by altering the direction of its advance, said escape passage being large enough for portions of the advancing strand to pass therethrough out of contact with said surface.
9. Apparatus for applying a substance to a strand which comprises:
a member having a rotatable surface carrying such
substance,
means for advancing a strand toward said member into
contact with said surface while said strand is bent
on itself and packed in a column several times the
strands thickness, whereby said surface may be contacted successively
with spaced segments of the strand,
means for maintaining pressure on said strand while
it is in contact with said surface,
means defining in conjunction with said surface an
escape passage through which said strand escapes
by altering the direction of its advance,
said escape passage being large enough for the portions
of said strand which intervened between said spaced
segments to pass through the passage out of contact
with said surface.

10. Apparatus for applying a liquid to a yarn which comprises:
an elongated chamber in which the yarn is packed and
bent upon itself,
means for advancing said yarn through said chamber
in that condition,
a roll positioned at the exit from said chamber arranged
to partially block said exit and adapted to carry the
liquid on its external surface,
means for contacting said surface with the yarn as it
leaves said chamber and for maintaining pressure
on said yarn during such contact,
said roll having its axis offset with respect to said
chamber so the pressure of the yarn thereon causes
said roll to rotate.

11. Apparatus in accordance with claim 10 in which said crimping chamber is defined by members,
at least one of said members being movable to widen
and narrow the gap between said member and the
surface of said roll, and
said movable member and the surface of said roll de-
fining a restricted passage through which said yarn
escapes as the roll rotates,
whereby movement of said movable member adjusts
the pressure on said yarn as it passes through said
passage.

12. Apparatus for applying a liquid to a yarn which comprises:
an elongated stuffer-box crimping chamber,
rolls for introducing yarn into said chamber to bend
the yarn upon itself and to pack it in the chamber in
a crimped condition and to force it through the
chamber,
a rotatable roll partially blocking the exit from said
chamber,
said roll being positioned with its axis offset with respect
to said chamber,
whereby said yarn as it leaves said chamber and presses
on said roll creates a turning moment in said roll
about its axis,
and means for applying a liquid to said roll.

13. Apparatus in accordance with claim 12 in which
said means for applying liquid includes
a font adapted to contain dye,
a transfer roll rotatable in contact with said partially
blocking roll and adapted to have a portion immersed
in a dye contained in said font.

14. In apparatus for applying liquid to a strand the
combination which comprises
a member having a rotatable surface carrying such
liquid,
means for advancing a strand toward said member into
contact with said surface while said strand is bent
on itself and packed in a column several times the
strand thickness,
a font adapted to contain the liquid,
a transfer roll rotatable in contact with said member
and adapted to have a portion immersed in the liquid
contained in the said font,
and a supply tube for said liquid extending downwardly
into said font and terminating at a lower end spaced
distance from the bottom of the font equal to the
depth desired for the liquid therein.

15. A method of applying a substance to a strand
which comprises:
providing a strand that has been bent on itself,
advancing said strand toward a member having a surface
carrying the substance to be applied to the strand,
contacting said surface successively with segments of
the strand and thereafter allowing said segments to
escape from contact with such surface,
allowing the portions of the advancing strand inter-
vening between said segments to advance past said
surface out of contact therewith,
and continuing to so advance succeeding segments of
said strand.

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