United States Patent [19]

Snyder

[11] **3,921,377**

[45] **Nov. 25, 1975**

[54] **PRODUCTION OF DYED FABRICS**

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[22] Filed: **Oct. 26, 1973**

[21] Appl. No.: **409,885**

[52] **U.S. Cl.** ..... **57/35**; 8/151; 68/205 R; 57/165

[51] **Int. Cl.²** **D06B 3/24**; D06B 11/00

[58] **Field of Search** ..... 57/7, 162, 35, 164, 34 AT, 57/165, 153, 156, 162; 8/151.1, 151.2, 149; 68/203, 205 R

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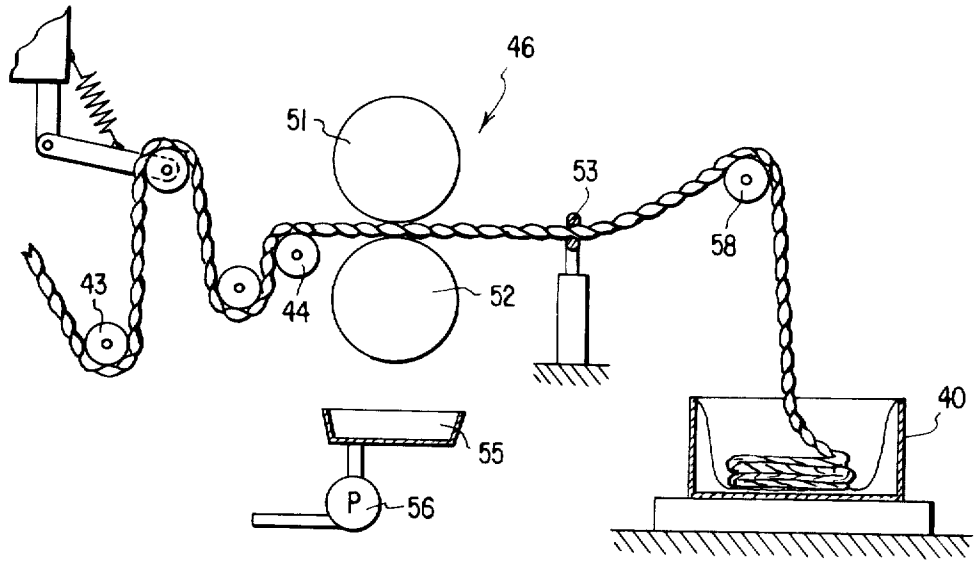
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[57] **ABSTRACT**

In a procedure for dyeing a length of fabric by conveying the fabric in the direction of its length through a dye station where the fabric is impregnated with a quick-setting dye, the dye is caused to non-uniformly color the fabric with a generally longitudinal, randomly varying pattern effect, by causing the fabric to pass through the station in a longitudinally twisted state. In order to enhance the effect of this procedure, and in particular to vary the general nature of the color variation produced, the fabric is manipulated ahead of the dye station by periodically varying its degree of twist and/or degree of compression transverse to its length.

9 Claims, 4 Drawing Figures



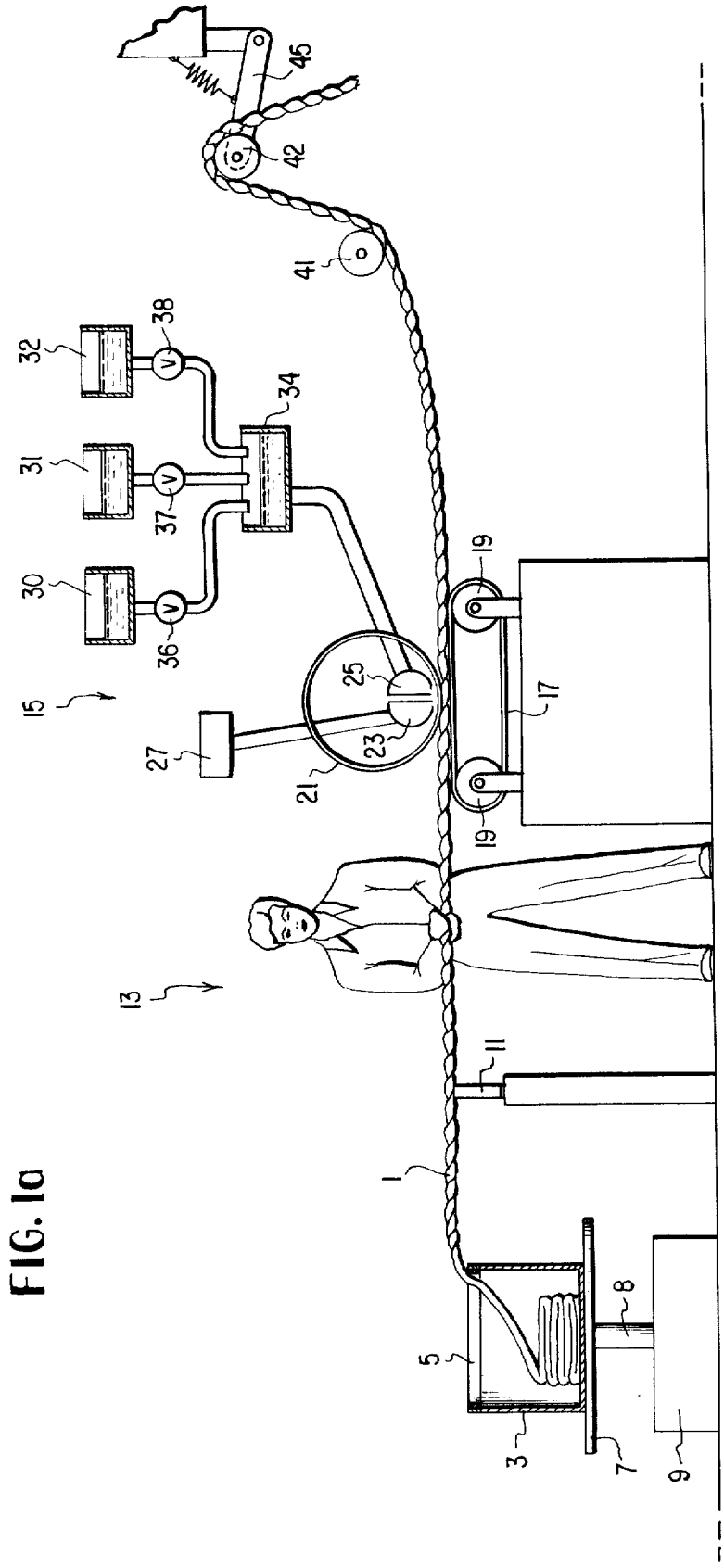


FIG. 1a

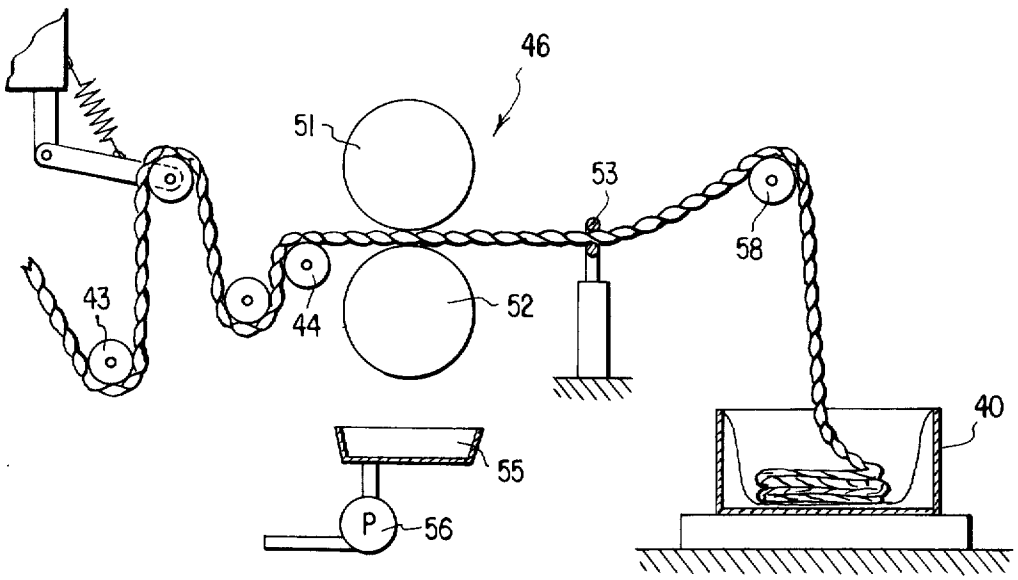


FIG. 1b

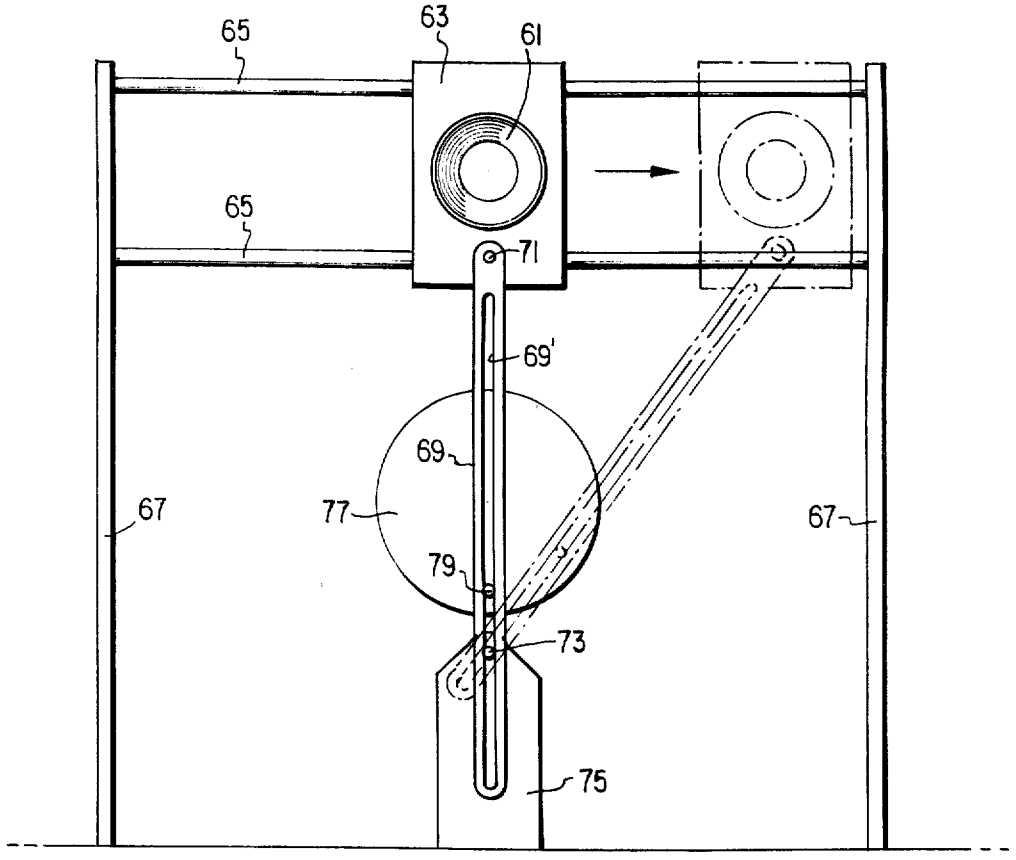
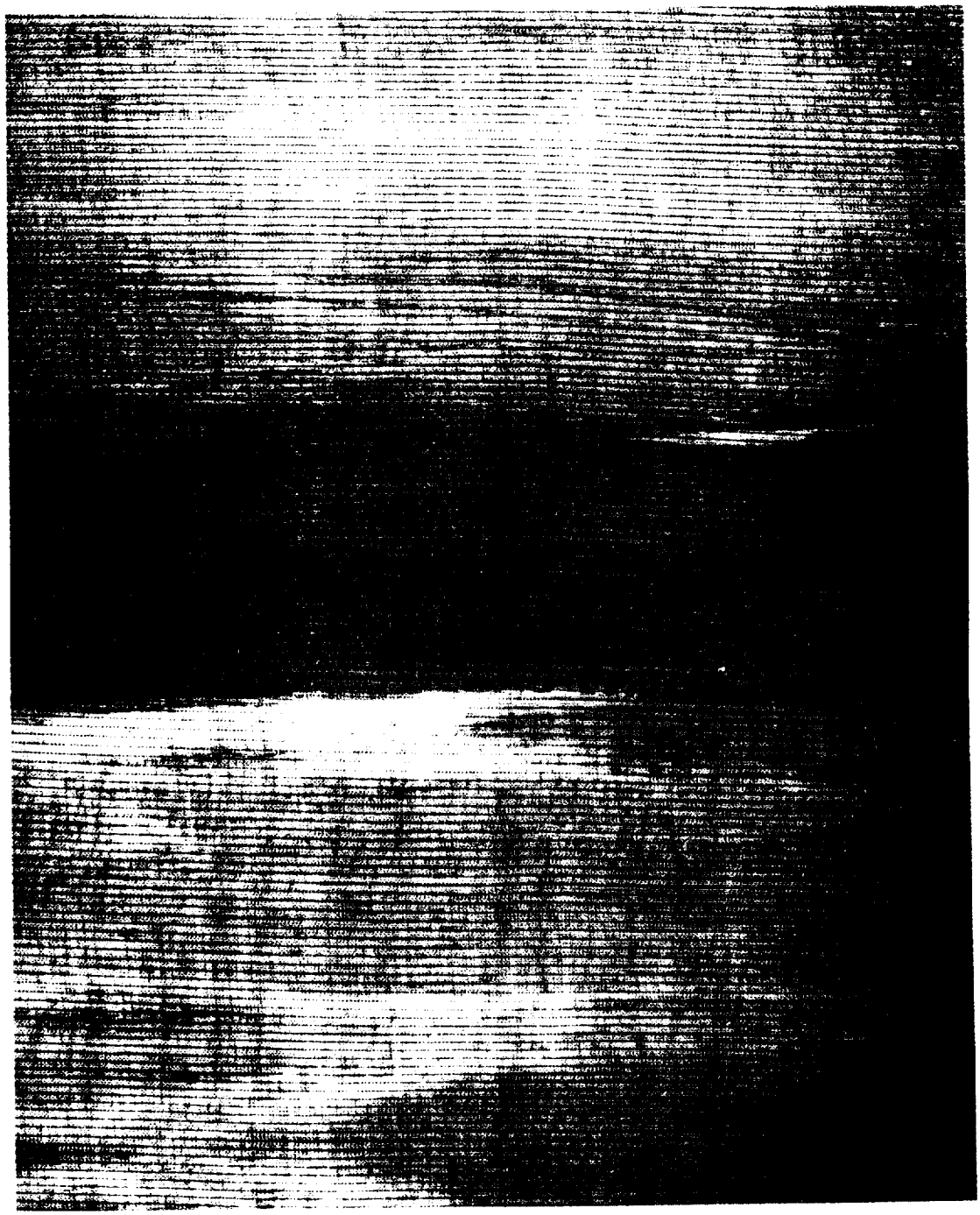


FIG. 2

FIG. 3



PRODUCTION OF DYED FABRICS

BACKGROUND OF THE INVENTION

The present invention relates to a method and apparatus for dyeing lengths of fabric, inparticular by conveying the fabric in the direction of its length through a suitable dye station from which dye is dispensed in a continuous operation.

The invention is particularly concerned with methods and apparatus of the type in which a substantially uniform dye distribution is provided by the dye station, as opposed to procedures designed to produce a regular pattern, i.e., printing procedures.

In the specific field to which the invention relates, it is usually desired to color the entire fabric as uniformly as possible. However, there is a market demand for garments made of fabrics having a randomly varying, non-uniform coloration.

While various efforts have hertofore been made to satisfy this demand, none of them has been completely satisfactory either because they do not produce a sufficiently random effect or because they involve time consuming manual operations and are thus unacceptably costly.

SUMMARY OF THE INVENTION

It is a primary object of the present invention to overcome these drawbacks.

A further object of the invention is to produce fabric having a coloration which varies randomly within selected limits.

A further object of the invention is to produce such fabrics at a high production rate and at low cost.

The invention is applicable to procedures in which a length of fabric is dyed by conveying the fabric in the direction of its length through a dye station where the fabric is impregnated with a quick-setting dye. The objects according to the invention are achieved by imparting a longitudinal twist to the fabric ahead of the dye station to cause the fabric to pass through the station in a twisted state, whereby the dye applied to the fabric will non-uniformly color the fabric with a generally longitudinal, randomly varying pattern effect.

The objects according to the invention are further achieved by manipulating the twisted fabric ahead of the dye station so as to impart variations to the effect produced within the dye station.

The objects according to the invention are additionally achieved by subjecting the fabric to subsequent operations which prevent the non-uniformity of the coloration imparted in the dye station from being diminished.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1***a* and **1***b* are elevational side views of successive portions of dyeing apparatus constructed and operated according to the present invention.

FIG. **2** is an elevational view of a unit according to the invention which can be used in the apparatus of FIG. **1**.

FIG. **3** is a photographic reproduction of a length of dyed fabric according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates one preferred embodiment of apparatus for carrying out the present invention. The primary purpose of this apparatus is to pass a length of fabric through a dye station while the fabric is twisted about its longitudinal axis. It has been found that the color pattern effect produced in the dye station can be varied by varying one or more of: the rate of travel of the fabric; the degree of twist, and the direction of twist of the fabric as it passes therethrough. The effect can also be varied by controlling the diameter of the twisted fabric. It can further be varied chemically by controlling the rate of diffusion of dye from portions of the fabric which are directly impregnated thereby to regions of the fabric which are not directly impregnated, this being achieved, for example, by providing the dye with a suitable amount of a penetrating agent.

As is shown in FIG. **1**, a length of fabric **1**, which preferably is in the form of knit greige goods, is initially supplied in a piled condition in a box **3**. The top of the box is provided with a circular hoop **5** oriented to coincide with the open top of the box and defining a circular outlet opening through which fabric is drawn from the box. The box **3** is placed on a turntable **7** supported by a shaft **8** driven by a suitable motor disposed in a stationary housing **9**. The leading end of fabric **1** is drawn over a metal detector **11**, of any suitable type. The leading end of the length of fabric is introduced into a dye station **15** to pass between a dye cylinder **21** and a belt **17** driven by rollers **19**.

Cylinder **21** is not itself directly driven by any drive unit. Rather, it is mounted to be freely rotatable and the fabric is pressed between cylinder **21** and belt **17** so that the fabric is advanced by the belt and, in turn, rotates the cylinder.

Upon initial introduction of the leading edge of fabric **1** into the dye station, turntable **7** is placed into rotation to impart a suitable twist to the length of fabric. The rate of rotation of turntable **7** is selected on the basis of the rate at which the fabric is to pass through the dye station and the degree of twist to be imparted to the fabric.

Thus, for example, for a fabric having a weight of 1.6 yards per pound, a good result has been achieved by advancing the fabric through the dye station at a speed of 50 yards per minute while rotating turntable **7** at a rate of 18 rpm.

At station **13**, the twisted fabric is displaced horizontally transverse to its length, i.e., along the axis of cylinder **21**, in a cyclic manner from one axial end of the cylinder to the other in order to distribute the wear over the entire surface of the cylinder. The displacement could be at a rate of several cycles per minute and can be effected either manually, by the workman, or mechanically.

The twisted fabric may be continually or periodically manipulated by a workman at work station **13**. This manipulation can serve to alternatingly provide a tighter and looser twist and/or to vary the degree of compression of the fabric transverse to its length. The latter can be achieved by alternately squeezing and releasing the fabric. All of these manipulations will vary the specific appearance of the generally longitudinal pattern effect produced on the fabric by the application of dye at station **15**.

Circular hoop **5** serves to prevent the fabric from being caught on the corners of box **3** and assists in twisting the fabric. The sliding of the fabric along the inner surface of the hoop helps to impart a uniform twist thereto. If the hoop were not provided, the fabric would wedge into the corner of the box nearest the dye

station and would then quickly slide to the next succeeding corner as the turntable rotates. This would interfere with the establishment of a uniform degree of twist along the length of the box. Hoop **5** is preferably constituted by a metal ring having a rectangular cross section, with a rubber layer attached to the inner surface of the ring. The rubber protects the fabric and provides a frictional contact surface for the fabric and thus aids in imparting the desired twist thereto.

In the dye station **15**, the fabric **1** is compressed between roller driven belt **17** and rotatable dye cylinder **21**. The device is the type used for continuous batch dyeing. The fabric advances through the station under the influence of the advancing movement of belt **17** and during this travel rotates cylinder **21**.

Cylinder **21** is constituted by a very thin, flexible metal sheet provided with a large number of small perforations. The ends of cylinder **21** can be constituted by relative rigid circular collars between which the metal sheet is mounted. The cylinder may be open at its ends and supported by sets of rollers which may bear against the collars defining the ends of the cylinder.

This construction leaves the interior of cylinder **21** accessible for receipt of tubes **23** and **25** which extend substantially the entire length thereof. These tubes are disposed adjacent the cylindrical wall of cylinder **21** close to the region of contact with fabric **1**. Tubes **23** and **25** are mounted to remain stationary while the cylinder rotates in contact with the fabric.

Each of the tubes **23** and **25** is provided with a longitudinal slot located generally at the lowermost point of its periphery, i.e., facing the fabric **1**. Tube **23** is connected to a vacuum source **27** producing a vacuum which communicates with the fabric through the slot in tube **23** and the perforations in cylinder **21** so as to extract a substantial portion of the air trapped in fabric **1**. Tubes **23** and **25** are provided, at least along each side of their respective slots, with a friction-reducing coating of a material such as Teflon or a polyamide. Cylinder **21** slides against these coatings when it is rotated by a length **10** of fabric.

Tube **25** is located immediately downstream of tube **23** and supplies, via its slot, the desired dye solution to the inner surface of cylinder **21**. This solution passes through the perforations in cylinder **21** and penetrates the fabric, this penetration being aided by the fact that the dye liquid tends to replace the air just previously removed from the fabric by the action of the vacuum in tube **23**.

Typically, each of the slots in tubes **23** and **25** has a width of the order of three quarter inch and the spacing between slots is of the order of 1 inch.

In order to achieve the desired coloration effect, use is made of quick-setting, fiber reactive dyes. The quick-setting character of the dye prevents it from transferring, or diffusing, to any substantial degree from one part of the fabric to another subsequent to passage between belt **17** and roller **21**.

The described apparatus at station **15** is a vacuum impregnator, which is known per se. The fabric is preferably dyed according to the known exhaust dye method and the ingredients of the dye solution are selected according to known principles on the basis of the color desired.

In the practice of the exhaust dye method, the dye solution is a mixture of a dye and an alkali in water or a bath of another liquid. A suitable mixture for dyeing operations according to the invention could be constituted by four parts dye and one part alkali, and the alkali could be constituted by a mixture of sodium silicate and caustic soda.

In order to permit the dyeing operation to be carried out on a continuous basis, the ingredients of the dye solution are preferably stored in separate containers **30**, **31** and **32**, although only two containers could be used. For example, the dye could be stored in one of the containers, and soda ash in the second of the containers. These two ingredients are delivered to a mixing chamber **34**, with the rate of supply of each component being controlled by a suitable controlled valve **36**, **37** or **38**, respectively. If it is desired to provide initially a large quantity of the dye, particularly when a mixture of four parts dye to one part alkali is to be used, the dye ingredient could be stored in two containers and the alkali in the third container. These valves are operated, by a suitable control system, to supply the individual ingredients at suitable relative rates. The rate of supply is selected to assure that the dye mixture formed in chamber **34** will be delivered to the fabric a sufficiently short time after the components thereof are brought together.

The dye treatment according to the invention can be performed on virtually any type of fabric, be it of natural fibers, man-made fibers, or blends thereof. It can also be performed on non-woven or woven fabrics, in addition to knitted fabrics.

The dye used to achieve the novel effect according to the invention can be virtually any type which is known to be compatible with the selected fabric. The requirement that the dye be quick-setting is satisfied by practically all dyes currently used in the industry and is a particular characteristic of dyes currently used for dyeing synthetic fabrics.

Thus, for a given material, the dye can be selected and applied according to the known principles employed in the dyeing industry and disclosed in various standard reference publications, one example of which is DYEING MAN-MADE FIBERS AND BLENDS, General Aniline & Film Corp. (1967). For cellulosic fibers, use is preferably, but not exclusively, made of fiber reactive dyes.

The fabric employed can have any suitable physical form, such as tubular or flat.

The present invention can also be employed to impart multicolored effects to fabrics. To achieve such effect a length of fabric is first dyed in the manner described above with reference to the drawing. Then, without being untwisted, and after the dye has been permitted to set, the length of twisted fabric is again passed through the same or another dye station **15** where a dye producing a different color is applied. Thereafter the fabric is aged and subjected to any necessary further treatments.

The resulting fabric will then have a multicolored appearance defined by individual areas, some of which are uncolored, others of which have the colorations of the respective dyes, and others of which have a coloration determined by the combined effect of the two dyes. Highly unusual and pleasing effects can be achieved in this manner.

One example of a suitable dye which could be used in the practice of the present invention is a monoazo dichlorotriazinyl derivative such as C.I. Reactive Orange 1. Such a dye is disclosed in the 1963 supplement of the publication COLOUR INDEX, second edition, at page S 493, The Society of Dyers and Colourists, England

(1956).

To assure that the dye will penetrate entirely through the body of twisted fabric, the dye solution can be supplemented by a suitable penetrating agent which overcomes the resistance to wetting created by the knitting oils remaining in the fabric. Such penetrating agents are known per se and, in the practice of the present invention, it has been found that such an agent assists in the migration, or wicking-out of the dye so as to produce intermediately shaded regions.

In the practice of the present invention, it is desired to produce fabrics having randomly shaped, but generally longitudinally elongated, regions of saturated color, similarly shaped regions which remain substantially uncolored, and regions having a color density which varies between saturated and uncolored. It has been found that a very pleasing appearance is achieved if, along every linear yard of fabric there are at least some uncolored regions constituting no more than 25 – 30% of the fabric area. FIG. **3** shows a length of fabric manufactured according to the invention and possessing these characteristics.

After leaving the dye station **15**, the fabric is conveyed around guide rollers **41, 42, 43** and **44** to a station **46** provided with two rollers **51** and **52** between which the fabric is conveyed.

At least one of the guide rollers, such as **42**, is mounted on a pivot arm **45** to which a suitably adjusted force is applied, as schematically represented by a spring, in order to maintain the length of fabric under a desired degree of tension.

Rollers **51** and **52** are mounted in a known manner (not shown) to be pressed toward one another in a manner to apply a substantially constant, controlled pressure to the fabric. The pressure provided by these rollers serves to force the dye into the fabric to produce the desired effect. It is desirable that the selected pressure level be maintained relatively constant since it has been found that when the fabric is subjected to an insufficient pressure level, undesired irregularities occur in the resulting pattern.

The pressure applied to the fabric by rollers **51** and **52** will serve to squeeze excess dye therefrom. This dye is collected in a catch pan **55** and recirculated therefrom, by a pump **56**, to the container **34**.

Beyond station **46**, the fabric is fed through a "pot eye" **53**, which is simply a metal ring having a smooth ceramic insert. Ring **53** is fixed in position with its center substantially coaxial with a line located in the space between rollers **51** and **52** midway between their ends and normal to the line joining the centers of the rollers. The purpose of ring **53** is to cause the fabric to be guided along a straight line away from rollers **51** and **52** so as to only contact the rollers at their nip. This helps to prevent dye from contacting and flowing onto the rollers and from thus being reapplied to the fabric. The pot eye also suppresses the cyclic movement of the fabric horizontally transverse to its length, which movement was introduced at the input end of dye station **15**.

The fabric, after passing through pot eye or ring **53** located midway between the sides of the device, is conveyed over a further driven guide roller **58** and then folded into a plastic bag held in a further box **40**. Roller **58** is covered with a suitable rough material to provide frictional contact with fabric **1**. The roller is driven at a suitable rate to pull the fabric through ring **53** in order to maintain the desired tension in the fabric length between ring **53** and rollers **51, 52**.

After a given length of fabric has been introduced into the plastic bag, the bag is sealed and removed from the box. Another plastic bag is then introduced into the box for receiving the next succeeding length of fabric. The bag which has been removed remains sealed for the period of time required for the dye to completely react. The period required could be of the order of 2 hours.

After this ageing period, the fabric may be removed from the bag, scoured and rinsed to remove unfixed dye and residual alkali. Then, in a further apparatus, water is extracted from the fabric as it is untwisted and a softening agent is applied.

The metal detector **11** upstream of dye station **15** is not essential to the dyeing operation according to the invention. However, when use is made of a thin, flexible member for cylinder **21**, it has been found that any metal present in the fabric can seriously damage the cylinder.

Insofar as concerns the results achieved by the present invention, it has been found that the twisting of a length of fabric before it passes through the dye station **15**, together with the use of a quick-setting dye, results in the production of a fabric which possesses an attractive, rough, elongated pattern effect. The quick-setting character of the dye employed assures that it will not be transferred from one part of the fabric to another after it has been supplied to the receiving box **40**.

For some purposes, it may be desired to cause the rate of movement of fabric **1** through dye station **15** to vary with the thickness of the fabric. For this purpose, a suitable thickness detector could be provided and connected to act in such a manner as to reduce the rate of feed of fabric through station **15**, the rate of rotation of turntable **7**, and the rate of delivery of the dye ingredients, as the fabric thickness increases.

The portion of the apparatus including dye station **15**, rollers **41–44** and nipping rollers **51** and **52** could be constituted by a known continuous pad batch dyeing vacuum impregnator of the type manufactured and sold by Sir James Farmer Norton & Co., Ltd., Manchester, England. In such a device the dimension of cylinder **21**, belt **17** and the rollers thereafter, normal to the plane of the drawing, is about 5 feet.

As has been mentioned above, the cyclic horizontal displacement of the fabric transverse to its length, at station **13**, could be achieved mechanically, as well as by a worker. FIG. **2** illustrates one possible embodiment of a mechanical traversing unit which serves this purpose.

The device shown in FIG. **2** includes a cone **61** whose diameter decreases toward station **15**. Cone **61** is disposed in, and supported by a housing **63** provided with slide openings via which it is slidably mounted on guide rails **65**. Rails **65** are in turn stationarily supported by posts **67** fixed to the ground.

The carriage **63** is mounted to slide freely along the length of rails **65** between posts **67**. For driving the carriage along this path, there is provided a pivot lever **69** having one end pivotally connected to the carriage at pivot point **71**. Lever **69** is provided with an elongated slot **69'** in which slidably engages a fixed pivot pin **73** attached to a stationary support **75** which is also fixed to the ground.

There is also provided a drive disc **77** carrying a drive pin **79** which also slidably engages in slot **69'**. Disc **77** is connected to the shaft of a suitable drive motor (not shown) selected and controlled to rotate at a speed cor-

responding to the desired rate of cyclic horizontal displacement of cone **61**. As disc **77** rotates, pin **79** causes lever **69** to undergo an oscillatory movement which displaces carriage **63**, and thus cone **71**, along rails **65**. Lever **69** pivots about pin **73** under the influence of the rotary movement of pin **79** and each rotation of disc **77** produces one full cycle in the movement of carriage **63** back and forth along the length of rails **65**.

When the arrangement shown in FIG. **2** is employed in the machine of FIG. **1**, it is located at station **13** and oriented so that the movement of carriage **63** along rails **65** is normal to the plane of FIG. **1**, i.e., parallel to the axis of cylinder **21**. At the start of operation, the leading end of the fabric is fed through cone **61** and introduced between cylinder **21** and roller **17**. While the fabric is being fed through dye station **15**, disc **77** is caused to rotate so as to cause the fabric to be continuously and cyclically displaced along the axis of rotation of cylinder **21**.

If desired, disc **77** could be linked to the drive for belt **17** so as to cause the rate of displacement of cone **61** to maintain a fixed relationship with the rate of movement of fabric through the dye station. In addition, cone **61** could be mounted and driven so as to rotate about its own axis in an oscillatory manner, and thus to provide to a certain degree the manipulation performed by a workman at station **13** when a mechanical system is not provided at that station. In this case, it might be desirable to provide the interior surface of cone **61** with a friction coating, for example of rubber, to enable it to grip the fabric sufficiently to cause the twist thereof to vary as the cone rotates in such an oscillatory manner.

The arrangement shown in FIG. **2** is, of course, only exemplary, and numerous other mechanical manipulating structures can be envisioned.

It will be understood that the above description of the present invention is susceptible to various modifications, changes and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

I claim:

1. In a method for continuously dyeing a length of fabric by moving the fabric in the direction of its length through a dye station where the fabric is impregnated with a quick setting dye, the improvement comprising imparting a longitudinal twist to the fabric ahead of the dye station to cause the fabric to pass through the station in a twisted state for causing the dye to non-uniformly color the fabric with a generally longitudinal, randomly varying pattern effect, and then storing the fabric, while maintaining it longitudinally twisted for at least the time required for the dye which has impregnated the fabric to completely react.

2. A method as defined in claim **1** wherein the dye station includes a rotatable dye delivery cylinder and further comprising displacing the fabric, at a point ahead of the dye station, in a cyclic manner transverse to its length and parallel to the axis of such cylinder.

3. In a method for continuously dyeing a length of fabric by moving the fabric in the direction of its length through a dye station where the fabric is impregnated with a quick setting dye, the improvement comprising imparting a longitudinal twist to the fabric ahead of the dye station to cause the fabric to pass through the station in a twisted state for causing the dye to non-uniformly color the fabric with a generally longitudinal, randomly varying pattern effect, and manipulating the fabric ahead of the dye station for periodically varying the degree of compression of the twisted fabric transverse to its length and the configuration of the twisted fabric as it passes through the station.

4. A method as defined in claim **3** wherein said step of manipulating includes periodically varying the degree of twist of the fabric.

5. In apparatus for continuously dyeing a length of fabric, which apparatus includes a dye station through which the fabric passes while travelling in the direction of its length and in which the fabric is brought into contact with a quick-setting dye in such a manner as to cause the dye to impregnate the fabric, the improvement comprising: means disposed ahead of said dye station and mounted for rotation for imparting a longitudinal twist to the fabric to cause the fabric to pass through the station in a twisted state for causing the dye to non-uniformly color the fabric with a generally longitudinal, randomly varying pattern effect; drive means connected to rotate said means for imparting a twist; and storage means for storing the fabric in its longitudinally twisted state after it has passed through said dye station.

6. In apparatus for continuously dyeing a length of fabric, which apparatus includes a dye station through which the fabric passes while travelling in the direction of its length and in which the fabric is brought into contact with a quick-setting dye in such a manner as to cause the dye to impregnate the fabric, the improvement comprising means ahead of said dye station for imparting a longitudinal twist to the fabric to cause the fabric to pass through the station in a twisted state for causing the dye to non-uniformly color the fabric with a generally longitudinal, randomly varying pattern effect, wherein said means for imparting a twist comprises a turntable arranged to receive such length of fabric in an initially untwisted state and to rotate as fabric is conveyed therefrom to said dye station.

7. Apparatus as defined in claim **6** wherein said turntable is oriented to rotate about a substantially vertical axis and said means for imparting a twist further comprises a circular guide hoop mounted for rotation with said turntable and oriented to lie in a plane inclined to the axis of rotation of said turntable, said hoop being arranged to permit the length of fabric to pass therethrough and bear against the surface thereof while traveling from said turntable to said dye station.

8. Apparatus as defined in claim **7** further comprising: subsequent treating means disposed beyond said dye station; first guide means for continuously guiding such fabric from said dye station to said subsequent treating means, and second guide means disposed beyond said subsequent treating means for guiding the fabric leaving said treating means while maintaining a fixed spatial relation between said treating means and the portion of fabric extending from said treating means to said second guide means.

9. A dyed fabric produced by the method defined in claim **1**.

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