Dec. 9, 1947. L. C. GALATIOTO 2,432,404

METHOD OF DYEING STRANDS OF TEXTILE FIBERS OR FILAMENTS

Filed May 3, 1944 2 Sheets-Sheet 1

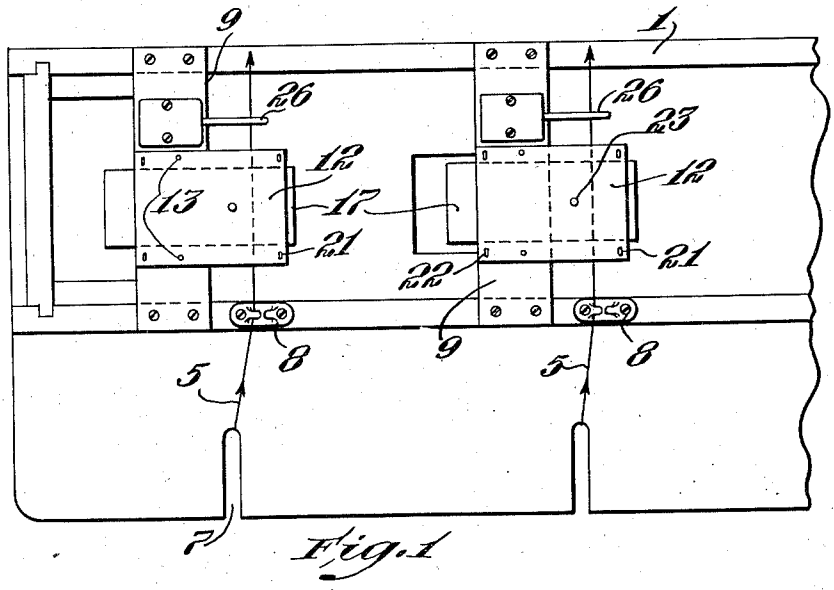


Fig. 1

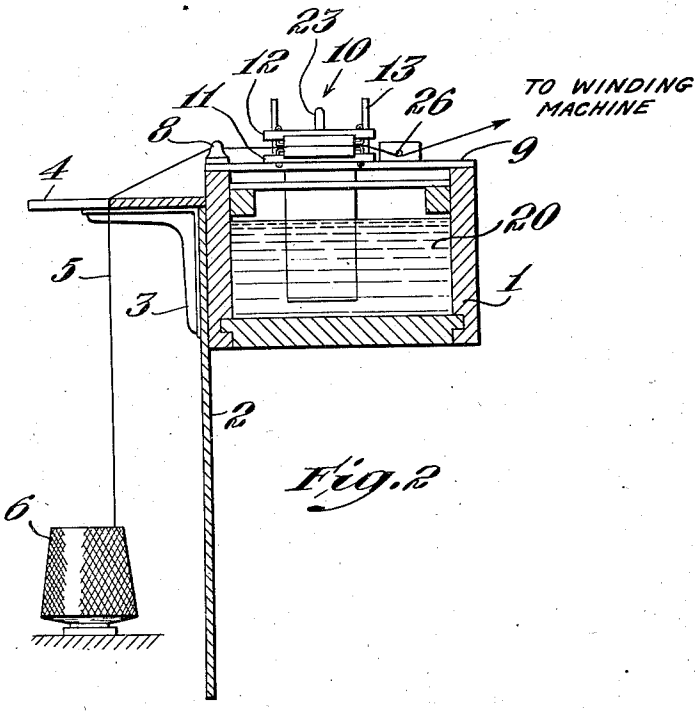


Fig. 2

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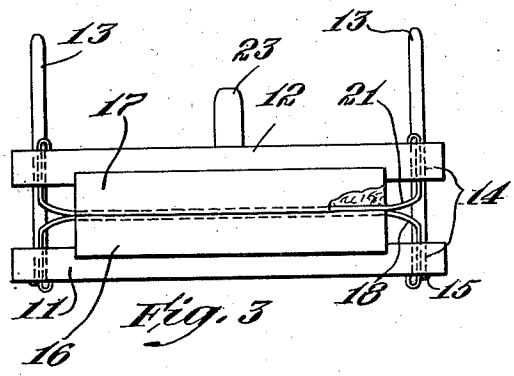


Fig. 3

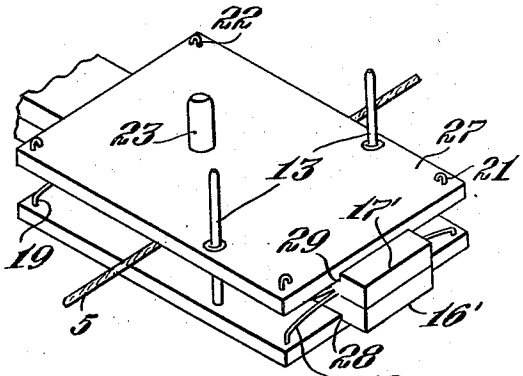


Fig. 4

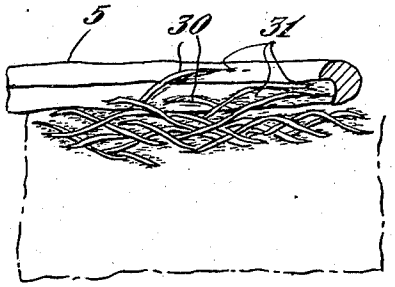


Fig. 5



Fig. 9



Fig. 8



Fig. 6



Fig. 7



Fig. 10

Fig. 11

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METHOD OF DYEING STRANDS OF TEXTILE FIBERS OR FILAMENTS

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Application May 3, 1944, Serial No. 533,904

2 Claims. (Cl. 8—151.2)

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The present invention relates to a method of dyeing a single-running strand of textile fibers or filaments.

In the dyeing of textile materials it is usual practice to dye them either in the form of finished textile goods, as in piece dyeing, or to dye the yarn or thread in the form of wound packages or skeins. For such dyeing operations, large and expensive apparatus is required, large batches of dye liquor are required, and high liquor ratios are customarily and necessarily employed. Such operations require considerable time to carry them out and to secure a satisfactory result. This is the case because previous procedures require time to effect exhaustion of the dye while in the dye bath, and vary from one lot to another and one dye to another. Moreover, the shade of dyeing depends upon the degree of exhaustion effected, which must accordingly be carefully watched and controlled throughout the process in terms of the dyeing time, temperatures, salting out effects, and judgment of the colourist. Moreover, they involve considerable special handling, such as winding and re-winding the yarn from cakes or cones into skeins or packages for dyeing, loading of machines, long period of dyeing operations, unloading the machines, hydro-extracting and drying.

In most instances it is desirable to dye large quantities of yarn, and, if possible and practicable from the standpoint of commercial dyeing, it would be desirable to dye them without involving dyeing operations separate from the regular manufacturing operations which are necessary.

It is accordingly an object of the present invention to provide a procedure for dyeing textile filaments, especially in the form of yarn or thread, without interrupting other manufacturing operations, and which shall nevertheless produce a satisfactory and dependable product, meeting the requirements of the textile industry.

It is a more particular object of the invention to provide a method which shall be applicable to both natural and artificial or synthetic filaments, threads or yarns, such as the various types of rayon, or nylon, with direct dyes. Other objects will appear from the following description.

In dyeing filaments or yarns it is necessary to effect complete and uniform wetting of all of the fiber surfaces with the dye liquor. To accomplish this it is usually customary to immerse a skein or a package of the yarn into the dye liquor and to pump the dye solution through the yarn, for a considerable period of time, to effect

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uniform and complete dyeing of the yarn by the dye liquor. Otherwise uniform dyeing of the package will not result.

The synthetic textile fibers are commonly obtained in a plastic or fluid condition, when fashioned in the form of filaments, fibers or threads. Consequently, they are subject to shrinkage, upon subsequent drying or setting to a more solid condition. Such shrinkage leads to more or less firming and slicking of the surface, sometimes followed by a wrinkling of the surface. This wrinkling forms irregularities and flutings of the fibers, which run more or less longitudinally throughout their entire lengths.

By the present invention it is found that textile fibers and filaments, both natural and artificial or synthetic, may be dyed satisfactorily at a high rate of speed, such as that of the usual winding machine operations, without the necessity of re-winding and other handling operations, which have been necessary and customary with such types of textile fibers heretofore. It is also found that uniform distribution, accurate matching of shades, and a high standard of dyed product, by all of the tests usually applied to dyed filaments, yarns and threads of these kinds may be secured by proper selection of dyes, formulations and procedures.

It will, therefore, be readily appreciated that many conveniences and economies may be attained by the present procedure, such as the elimination of the necessity for dyeing apparatus, the large volumes of dye liquor, due to high liquor ratios, the long drying time required for drying saturated skeins, packages, and the like. The dyeing operation may be accomplished in either small or large lots, and yet with the facility of quick output and a high quality of product, together with the economies accompanying each of these advantageous features.

The process of the invention comprises the discovery that although a filament or yarn may be only capable of being moderately or slowly wetted by a dye solution, it may nevertheless be wetted uniformly and thoroughly by such solution at a high rate of speed by contacting it with a film of the solution, at relatively small points or areas of its surface, under light or moderately firm pressure. Such filaments may be completely surrounded by such contacting points or areas of film, and if each contacting point or area of film is drawn along the fiber surface, or, conversely, if the fiber is run against the contacting film, such film of dye solution will intimately contact, wet and associate itself with the surface

of the fiber continuously and uniformly throughout the length of the filament. Moreover, it will distribute itself over both smooth and irregular surfaces of the filament, thread or yarn, and penetrate into the same uniformly throughout its length, at an extremely rapid rate, and fully equal to that of the usual winding machine operations, as above noted, namely about 325 yards per minute or more.

Moreover, it is a characteristic feature of this process of dyeing that the filament, yarn or thread, is given a uniform film (and subsequent impregnation) of the dye liquor, which may be definitely determined by the pick-up of the dyeing liquor, and this determines the depth of shade of the dye effect on the filament, yarn or thread. The pickup in any given case is controlled by the rate of feed of the dye solution to the filament and the relative rate of speed of the filament and the contacting film of dye solution.

A typical and representative example of the practical carrying out of my invention will be described with respect to the dyeing of rayon yarn as it is being wound or re-wound (or during like required operations), reference being made to the accompanying drawings.

Apparatus which is convenient and satisfactory for carrying out the invention in practical commercial operations is disclosed and claimed in my copending application Serial No. 500,174, filed August 26, 1943, and is illustrated in the accompanying drawings, in which:

Fig. 1 is a plan view of a treating bath and controlled capillary means for feeding the dye liquor to the filament;

Fig. 2 is a vertical section and side elevation, showing the filament to be treated, as viewed along the course of travel of the filament, as shown in Fig. 1;

Fig. 3 is an enlarged detail of a pair of loose ended, felted, fibrous, capillary wicks, between which the filament is fed to effect treatment with the dye solution;

Fig. 4 is an enlarged detail in perspective, similar to that of Fig. 3;

Fig. 5 is an enlarged view of a filament, showing the irregularities and flutings therein and the relationship and action of the fibers, with attenuated points of the film of dye solution thereon, and the points of incidence of their contacts with the filaments; and

Figs. 6 to 11, inclusive, illustrate typical cross-sections of fibers of cuprammonium, nitrocellulose, cellulose acetate, viscose, cotton and wool, respectively.

In the drawings the tank 1 is set upon any suitable support, conveniently arranged with respect to the source or location of the filament to be dyed, and may be provided with an apron 2 in front and a bracket 3 supporting a shelf 4 which serves as a guide for the filament 5, such as yarn or thread, as it is fed or delivered to the apparatus. As shown, it may be fed from a package or cone 6, through the guide slot 7 and guide 8 mounted upon the front edge of the tank.

A bridge 9 across the top of the tank 1, from front to back, supports the applicator 10 which may comprise a rectangular piece of composition board 11, such as Masonite, fastened to the bridge and a second similar piece of board 12, of the same size and shape, mounted thereon by a pair of vertical guide posts 13, which pass through holes 14 in both boards (Fig. 3) and are secured to the under side of the lower board, as by a drop of solder, at 15. Two masses of felted wool

fibers, 16, 17, pass between the boards and overlie each other. They are sufficiently long to overlie the bridge 9 and board 11 and to dip into the dye bath solution in the tank 1 at either one end or both ends, as desired, depending upon the rate of feed of the dye solution which is required. The rate of feed may also be regulated by adjusting and then fixing the height of the horizontal, overlying portions of the wicks above the level of the dye solution (Fig. 2).

The fibrous material is preferably composed of fine fibers, which terminate in finely pointed, flexible but resilient ends. These masses of fibers are so arranged and disposed that many ends tend to project from the surfaces of each mass, which are then placed in opposition. They should not mat together. On the other hand, these individual projecting fibers must be sufficiently resilient to remain separate from each other, even when freely wetted by films of the dye solution, both under the pressure of light or firm contact between the masses and against the surfaces of the filament which is to be contacted by them. Fine fibers of wool, in the form of loosely felted or picked up wicks, may be prepared and used, preferable with the free, tapered ends of the surface fibers projecting outwardly. These are especially suitable for the purpose, when of sufficient thickness and closeness of packing, to induce capillary attraction of the dye solution, in opposition to gravity, and in continuous, thin films throughout the length of the wick, the lengths of the free surface fibers, and over their free projecting ends.

The lower wick is held firmly in position against the lower board at each end by the wires 18 and 19, but not sufficiently to compact the fibers or interrupt the capillary flow of dye solution therethrough, while the upper wick 17 is similarly held to the upper board at each end by similar wires 21, 22. The post 23 on the upper side of the upper board may serve as a handle to raise and adjust the upper board and wick, or to separate the wicks and observe their functioning, or to receive and hold weights thereon (not shown) if it is desired to compress the wicks or hold them more firmly together. This may be necessary, in view of the loose, free and somewhat resilient characteristics of the fibers, in order to assure a uniform capillary flow of the dye solution, not only upward through each wick but also into and between their opposed surfaces. But too great compression is to be avoided since it may compact the fibers too firmly together and prevent the individual free resiliency of each from effecting intimate contact and from entering into the irregularities of the surfaces of the filament to be wetted by them.

In this way the capillary flow of the dye solution 20 from the tank, up through the vertical and horizontal portions of both wicks, throughout the surfaces of both wicks and of the fibers projecting therefrom, and thence onto the filament 5, which is led between those portions of the wick which lie horizontally together between the boards, may be readily adjusted and accurately controlled. The wicks preferably have the characteristics of loose fibers, each fiber being thoroughly wetted with the dye solution and numerous freely projecting fiber ends adapted to come in intimate contact with the filament 5 to be dyed, as it is drawn between them. They are not compacted, matted together, fibrous masses saturated with continuous volumes of the liquid, for these would not be effective to transfer such liquid

masses quickly nor uniformly and intimately to filaments of the character here in question, nor at the required speed, with desirable results. Likewise, it would not be adequate merely to run the strand of yarn or thread through a dye bath for this purpose.

On coming from between the wicks, the filament or yarn 5 is drawn beneath a horizontal, fixed glazed porcelain guide post 26 and thence to a take-up or winding machine 30, where it may be wound into tubes, cones, packages, etc. of any convenient size. When these are filled, they may be dried in the usual ways. They will, however, require much less drying time than similar packages of yarn which have been dyed by the usual procedures, for a less volume of the dye solution may be used upon them than is required by other dye operations. In addition to this factor, the dye solution may be made of substantially any concentration desired, limited only by the dye solubility. By using a more concentrated dye solution, a correspondingly smaller volume of dye solution upon the filament will be sufficient for a given shade, and yet satisfactory dyeing will be effected, while less liquid is then present to require evaporation in the drying operation.

However, certain limitations must be observed, e. g., to provide an adequate volume of the dye liquor and a sufficient temperature, in order to effect the dyeing during the drying operation, so as to insure the penetration of the dye into the filament, rather than simple evaporation, precipitation and deposition of the dye upon the outside of the filament, without adequate penetration and fixation. In this way complete exhaustion of the dye by the filament is effected. Consequently, the dye bath solution is not altered during use, in respect of either its composition or its concentration. Hence, a uniform dye liquor is applied in uniform quantities throughout the periphery and throughout the length of the filament. It is completely absorbed and exhausted, in situ, on and within the filament. The dye solution left in the tank is consequently maintained of standard concentration and quality.

In the procedure of the present invention, therefore, the filament, yarn or thread is drawn into intimate contact with numerous freely projecting ends of the fine wool fibers of the felts or wicks. The latter are wetted with continuous films of dye solution, and as the dye solution is withdrawn by the filament in moving past them, the fibers in turn draw more of the dye film upwardly through the wicks from the dye bath solution 20, by surface and inter-surface capillarity.

The filament, in its rapid movement against or through the fibrous wicks, draws off from the end of each fiber 30 an attenuated film of dye solution 31 (Fig. 5) and becomes continuously wetted by it. By multiplying the number of fine, separate, resilient, dye-wet fiber ends of the felts, with which the filament 5 thus comes into contact, the pointed films of dye solution thereon will be sufficient to touch every point in the periphery of the filament and wet it. These separately applied, finely pointed films or streaks of dye solution not only intimately wet and adhere to the surface of the filament with which they are contacted, but in conjunction with the rubbing action of the fibers, simultaneously remove and eliminate adsorbed gases therefrom, which escape from between the advancing contact points of liquid dye film. By multiplying the number of these points of dye-wetting contact around

the filament, the applied points or films of dye solution not only wet the film surface intimately under the pressure of contact of the fibers from which they are drawn, but also merge together laterally thereafter and thus disperse and distribute themselves over the entire periphery of the filament, including the uneven internal surfaces of the grooves or flutings above referred to, as well as the smooth, externally rounded surfaces also. As the filament is run through the apparatus at extremely high rates of speed, these contacting and merging films of dye solution coalesce and constitute a rapidly forming and progressing film over and into the entire surface of the filament, in spite of its irregularities and flutings, throughout its length.

For example, in one instance of commercial application of the invention, a bright rayon yarn of 300 denier, was drawn from 3 lb. cones and run through the apparatus illustrated in the drawings, and taken up on a usual type of Universal winding machine in 12 oz. packages at a speed of 325 yards per minute. (With higher denier yarns or threads a somewhat lower rate of speed may be desirable, or higher speeds of the yarn may be employed by using wider wicks, etc.) The dyeing solution used was made up in aqueous solution as follows:

	Grams per liter
Erie Orange WS (National Aniline Chemical Corp.)	.119
Pontamine Fast Yellow NNL (E. I. du Pont de Nemours)	.00954
Glauber's salt	1.00

The dye liquor in this operation was taken up by the yarn in the proportion of about 70% of dye solution upon the weight of the yarn treated. The wound spools were dried in usual dryers at 170° F. in about 10 hours. The resulting product was not only satisfactory by all commercial tests, but also in respect of matching the shade required. The procedure was conducted at the usual winding speed so that no slow-down in the operation was required in order to effect completely satisfactory application of the dye solution to the filament at the usual rate at which it was taken up by the winding machine. Complete exhaustion of the dye substance was effected upon drying so that the yarn was truly and evenly dyed.

A darker shade, as, for instance, a blue which is used at this time for the electrical wire trade, was obtained by using a solution of:

	Grams per liter
Chloramine Blue 3B	8
Chloramine Blue 2B (Sandoz Chemical Wks.)	2
Glauber's salt	1.5

It may be remarked that whereas Glauber's salt is frequently added in dye bath procedures, in order to promote the exhaustion of dye from the bath by the goods, toward the end of the dyeing operation, the Glauber's salt is here already present in the dye bath solution as it is applied to the yarn. By so doing, a film of dye liquor of uniform composition is applied, containing both dye and Glauber's salt in appropriate proportions in the solvent so that, during the wetting penetration and even distribution over and into the filament, it becomes competent also to be completely exhausted by and into the yarn, to be fixed and developed therein, and then to give up its volatile solvent component or components, during the usual drying operations, leaving a truly fast dyed filament, yarn or thread, as contrasted

with a deposit of dye on the surface only, which may result from excessive dye or too rapid drying, or migration of dye, in a saturated cone or package, which may occur in accordance with procedures of the prior art.

I claim:

1. A method of dyeing textile filaments, yarns and threads, which are characterized by being wrinkled with longitudinal irregularities and flutings in their surfaces whereby they are rendered resistant to quick wetting by the dye solution, comprising the steps of running a strand of the same longitudinally between and in contact with two surfaces of a fibrous material, each surface having a multiplicity of resilient, fine-pointed, outwardly projecting fiber ends disposed in closely spaced apart relation to each other in fine, separate contacts with the surface of the running strand and supplying dye solution to the material, whereby films of the dye solution on the ends of the projecting fibers are severally and intimately contacted with the strand and drawn longitudinally thereof to effect a uniform wetting contact and distribution of the dye solution on the strand.

2. A method of dyeing textile filaments, yarns and threads, which are characterized by being wrinkled with longitudinal irregularities and flutings in their surfaces whereby they are rendered resistant to quick wetting by the dye solution, comprising the steps of running a strand of the same longitudinally between and in contact with two surfaces of a felted fibrous material, each surface having fibers disposed in thickly and closely packed capillary relation to each other and also having a multiplicity of resilient, fine-pointed outwardly projecting fiber ends disposed in closely spaced apart relation to each other in fine, separate contacts with the surface of the running strand and supplying dye solution to the material, whereby films of the dye solution on the ends of the projecting fibers are severally and intimately contacted with the strand and drawn longitudinally thereof to effect a uniform wetting contact and distribution of the dye solution on the strand.

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The following references are of record in the file of this patent:

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