June 20, 1967 L. DRAGO 3,326,022

APPARATUS FOR THE CONTINUOUS DYEING OF TEXTILE FIBER MATERIALS WITH A DYE LIQUOR

Filed Oct. 4, 1965 2 Sheets-Sheet 1

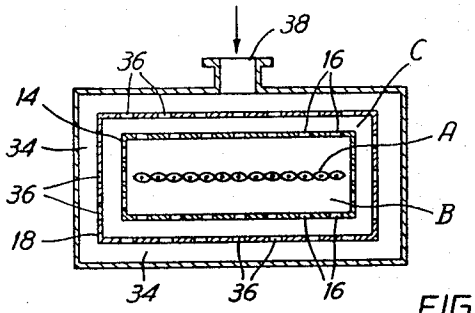


FIG. 2

FIG. 1a

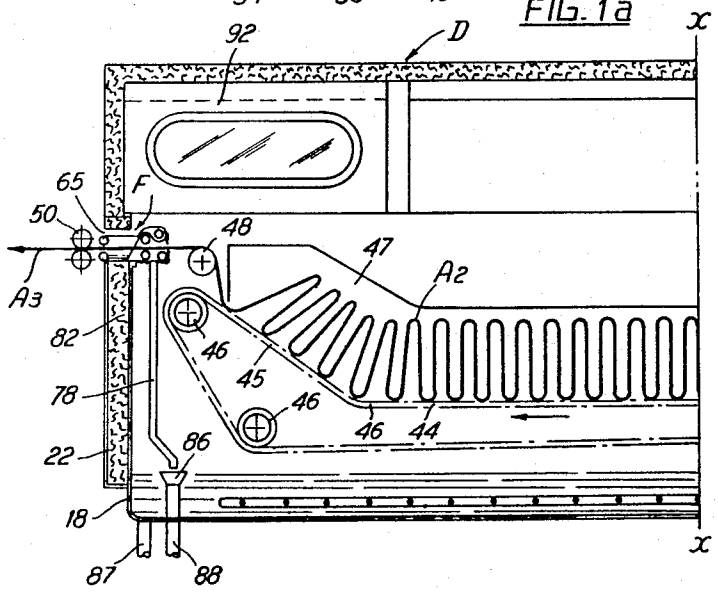
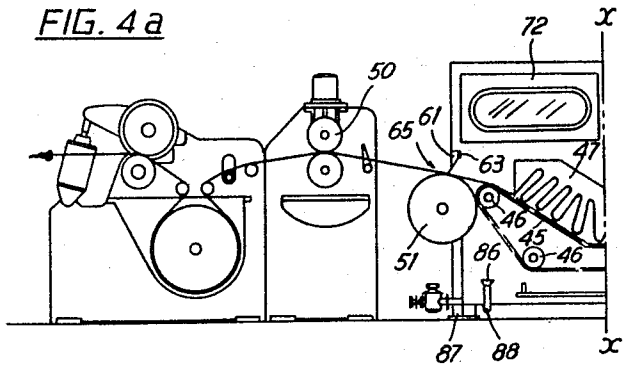


FIG. 4a



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FIG. 3

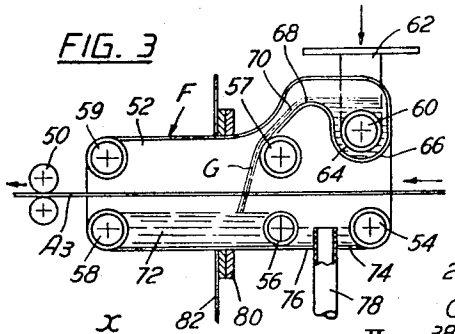


FIG. 1b

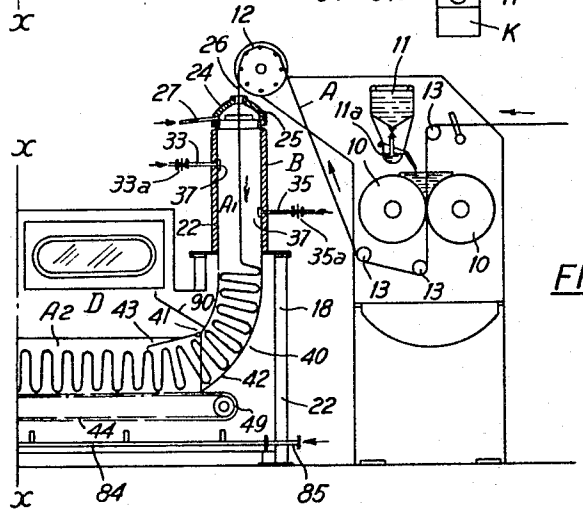


FIG. 4b

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United States Patent Office 3,326,022 Patented June 20, 1967

3,326,022

APPARATUS FOR THE CONTINUOUS DYEING OF TEXTILE FIBER MATERIALS WITH A DYE LIQUOR

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Filed Oct. 4, 1965, Ser. No. 492,725
Claims priority, application Italy, July 1, 1963, 36,702/63
19 Claims. (Cl. 68—5)

This application is a continuation-in-part of my now abandoned application Ser. No. 338,381, filed Jan. 17, 1964.

The present invention relates to an apparatus and process for the continuous wet-treatment and especially the dyeing of textile fiber materials such as wool and similar fibers with a dye liquor.

More particularly, the invention relates to the continuous dyeing of polyamide and acrylic fiber materials in the form of "slubbings" (or "tops").

By the expression "slubbings" (or "tops") there is meant any product known in the spinning and weaving art as slubbings or tops, card slivers, spun ribbons, woven fabrics or the like. This expression also comprises tow. Wherever slubbing is treated according to the process and in the apparatus of this invention, tow can be treated equally in lieu of slubbing.

The concept of dyeing wool and other textile fibers, especially in the form of slubbing and the like, in a continuous process is not new. Many and varied suggestions have been made as to ways in which this may be accomplished. There is, for example, the method of using neutral or acid steam for fixing the dyestuff after the latter has been deposited on the wool. The use of an atmosphere of steam for fixing a dyestuff has also been known for a long time in the textile printing art. However, with the exception of the Vigoureux process, this method of after-treatment with steam has not, up to quite recently, been found to be economical in the case of wool and the like textile fiber materials because the resulting dyed goods usually present a skittery, i.e., unevenly dyed aspect. On wool, a prerequisite of successful dyestuff fixation with steam is that the steam is saturated but not superheated. There are in existence machines with which woolen piece goods, but no slubbings, can be dyed by this process.

There are also other machines for the dyeing of wool slubbing which consist mainly of a large container in the form of a horizontally disposed cylinder which is provided at one end with a socket for admitting the dyed but still unfixed slubbings and at the other end with a discharge pipe for the steam-fixed dyed slubbings. In the opening of the feed socket, there is often housed a pad mangle which closes this socket against the escape of steam while feeding the slubbing therethrough into the interior of the cylinder. The outlet pipe is provided with a series of rollers which, at the same time, close the pipe against the escape of steam while effecting withdrawal of the slubbing from the cylinder. In the interior of the cylinder, there is provided a conveyor belt for moving the slubbing, fed onto the same through the entry socket, toward the outlet pipe. Slubbings are placed by means of a cutling frame or other conventional means on one end of the conveyor belt, while from the other end of the conveyor belt, the steamed slubbing is withdrawn through the aforesaid series of rollers in the outlet pipe.

Steam is continuously fed into the cylinder in an attempt to maintain in the latter the atmosphere most favorable for fixing as explained hereinbefore, namely saturated steam, while the cylinder is being heated simultaneously to operational temperature.

However, it is very difficult to control the rate of steam and the temperature sufficiently exactly to maintain the desired optimal atmosphere. Instead, the steam atmosphere in the cylinder is frequently either superheated or moist, resulting either in skittery or insufficiently fixed dyeings of wool slubbings.

Many of the above-mentioned difficulties have been overcome in a known, more recent apparatus for fixing on slubbings, e.g. of wool, the dyestuff which has been applied thereto from a dye liquor, which apparatus comprises means for contacting the slubbings with steam for heating and simultaneously moistening them, and comprises as a principal element of construction a vertically disposed J-tube open at both ends and being located beneath a padding device, which J-tube comprises:

(a) An upper section serving as a steam room, and

(b) An elongated, tubular lower section of approximately J-shaped longitudinal section, which lower section is freely communicatingly connected with the top end of the J to the bottom of said steam room, and has a smooth inside surface.

The lower portion of the substantially J-shaped longitudinal section extends with the longer straight portion of the "J" downwardly from the upper section, the longer straight portion being preferably from about 8 to 12 times as long as the upper section of the J-tube is high, while the shorter portion of the "J" extends upwardly at an angle from the lowermost zone of the "J," which angle is about 30° to 70°, depending on the ratio of the length of said lower portion to that of the said longer straight portion.

Finally, this known apparatus comprises means for withdrawing the fixed dyed slubbings from the open exit of the lower section of said J-tube.

The J-tube is provided with a feed opening adapted for admitting the still unfixed dyed slubbings from the padding device exclusively under their own weight into the interior of the J-tube, devices for introducing fresh steam in jet form directly into the upper portion of the J-tube, into direct contact with the slubbings introduced thereinto, while preventing the steam in jet form from impinging directly on the slubbings and preventing water particles carried by the steam from coming into contact with the slubbings.

This otherwise highly satisfactory apparatus suffers from the drawback that, in industrial operation, it requires undesirably high structures. The J-tube arrangement alone may attain heights of 12 meters, and, if undesirable length of travel of the impregnated, but still unfixed textile material is to be avoided, it is then necessary to provide a padding station at such undesirably high level above the foundation of the dyeing plant.

Another drawback resides in a certain lack of control of the relative conditions prevailing in the upper section serving as steam-room and the subsequent lower section of the J-tube.

It is, therefore, an object of the present invention to provide an apparatus for the continuous dyeing and steaming of pad-dyed slubbing or tow, e.g., of polyamide fibers such as wool or nylon or of acrylic fibers, whereby dyed and fixed slubbings of unobjectionable quality are obtained, the dyeing being fully fixed and perfectly even over the whole length as well as the entire cross section of each slubbing or tow.

This, and other objects which will become apparent hereinafter, are attained, according to a first aspect of the present invention, by a process which comprises:

(a) Saturating a slubbing or the like textile material as defined with at least one bath of padding liquor,

(b) Squeezing the material out to remove therefrom

liquor exceeding a limit amount of about 50 to not more than 200% of the weight of the impregnated goods,

(c) Subjecting the squeezed material during a downward movement thereof through a zone A_1 in a loose state and free from contact with any supporting and/or conveying means to a first, preliminary thermal treatment with dry steam whereby the treating bath components are prefixed on the fibers of the material to such a degree that no substantial amounts of dye are left capable of migrating along the fibers of the impregnated material,

(d) Deflecting the prefixed material gradually from its downward to a substantially horizonal movement preferably while causing the same simultaneously to form uniform folds, and

(e) Subjecting the prefixed and preferably folded material during its subsequent horizontal movement through a zone A_2 in which the folds are preferably in vertical position, to a second thermal treatment, preferably with steam, which treatment is separate from the thermal treatment under (c), while substantially no exchange of heating medium takes place between the two zones of treatment in steps (c) and (e).

During the stage (c), the residual pad-liquor on the slubbing spreads throughout the fibrous structure of the latter to attain a uniform distribution thereon and to penetrate to a sufficient degree into the fibers so that at the end of this treatment no further extraction of dye with water or further migration of the liquor along the fibers in significant amounts are possible.

The downward movement of the material through the prefixing zone A_1 should take place at a constant, substantially uniform rate.

On leaving the prefixing zone, the prefixed slubbing is deflected gradually by an angle of about 90° and is thus caused to move on in a substantially horizontal direction through the subsequent second fixing zone A_2 in which treatment the prefixed dye-liquor penetrates from the outer fiber layers into the core of each fiber, whereby the fixing treatment is completed.

It is very important that, during the deflection about an angle of about 90°, the slubbing or the like material be laid into folds which retain a substantially vertical arrangement throughout the movement of the material through the second fixing zone, A_2.

In the following, there are given preferred ranges of conditions to be observed in the prefixing zone A_1 on the one hand and in the second fixing zone A_2 on the other hand.

When treating wool slubbing, especially when it is impregnated with metal-complex dyes, travel rates of the slubbing range from 4 to 8 meters per minute and an atmosphere of saturated steam of 98° to102° C., in the zone A_1 are recommended. For the same material, a treatment period of 15 to 30 minutes and an atmosphere of saturated steam of 102 to 103° C. are recommended in the fixing zone A_2. Essentially the same applies to woolen tow.

When treating nylon slubbing, similar conditions are recommended for both fixing zones as in the case of wool, but the temperature especially in the fixing zone A_2 may also be somewhat higher.

In the case of acrylic fibers, travel-rates of 5 to 7 meters per minute and a superheated steam atmosphere of 102° to 107° C. for prefixing zone A_1 and a treatment time for each slubbing fold from 15 to 20 minutes and an atmosphere of overheated steam of 102° to 107° C. in fixing zone A_2 are recommended. Darker shades require a longer presence of the slubbing folds in the fixing zone A_2 and, correspondingly, a lower travel rate of the slubbing in zone A_1.

Excessively low travel-rates in zone A_1 and excessively long presence of the textile material in zone A_2 lead to color-losses in the surface layer of the fibers causing an undesirable "sandwich effect."

A preferred apparatus for carrying out the process according to this aspect of the invention comprises, in a first type of embodiment, a padding station of known construction consisting of one or more treating baths in combination with squeezing members, and subsequently arranged a novel kind of steaming station comprising at least one vertically disposed prefixing chamber, means for feeding padded and squeezed, but still unfixed slubbing or the like textile material from above into the prefixing chamber, heating means associated with the prefixing chamber and adapted for introducing heating fluid into the latter, deflecting duct means in free communication with the lower opening end of the prefixing chamber, conveying means arranged above the prefixing chamber to facilitate feeding of the slubbing or the like material into the latter chamber along the vertical axis of the said chamber, holding the slubbing substantially equidistant from the walls of said chamber.

The width of the prefixing chamber, i.e., the distance of its walls from the material passing therethrough must be sufficient to permit full blowing of the slubbing in the prefixing chamber without causing any frictional contact between slubbing and wall and to permit the formation of well-developed folds in the deflecting duct below the prefixing chamber.

The curvature of the deflecting duct extends through an angle, measured along the central axis of the duct, which ranges from at least 45 to not more than 90°, and preferably through an angle of 60 to 80°; the radius of the curved portion of the central duct axis should be at least equal to twice the internal width of the prefixing chamber and preferably not exceed about three times that width, taken in the plane of the said curved central axis portion.

The curved deflecting duct opens with its lower discharge end into a second fixing chamber the longitudinal horizontal axis of which is perpendicular to the axis of the prefixing chamber.

The length of the pre-fixing chamber ranges from about one eighth to one third of the longitudinal extension of the second fixing chamber D.

Preferably, the portion of the upper reach of the conveyor means which extends from the lower open end of the deflecting duct to the discharge end of the upper reach where the dye-fixed slubbing is taken off the conveyor, is about four to five times as long as the prefixing chamber is high.

In another type of embodiment of the apparatus according to the invention two or more pairs of padding stations and steaming stations are arranged in series.

The length of the curved duct portion should be from about the same to not more than twice the height of the pre-fixing chamber. Preferably it should not exceed one and a half times the length of the latter chamber.

The apparatus aspect of the invention is further illustrated in the accompanying drawings in which

FIGURES 1*a* and 1*b* taken together represent a longitudinal sectional view through a first embodiment of a steaming station forming part of the apparatus according to the invention;

FIGURE 2 represents an enlarged sectional view along line II—II of a portion of the apparatus section shown in FIGURE 1;

FIGURE 3 is an enlarged detail view of the exit region of the apparatus section shown in FIGURE 1;

FIGURES 4*a* and 4*b* taken together show a longitudinal sectional view of a preferred embodiment of the apparatus according to the invention.

Relating now to the drawings more in detail, and in particular to FIGURES 1*a*, 1*b* and 2 thereof, the embodiment shown therein comprises a steaming station consisting essentially of a pre-fixing chamber B and a second or main fixing chamber D. Above pre-fixing chamber B there is arranged a couple of squeezing rollers **10**. These squeezing rollers pertain to the padding station the re-

mainder of which is not shown in these figures. Squeezing rollers **10** serve to squeeze off padding liquor from the slubbing A while withdrawing the latter from the impregnation bath or baths of the padding station and conveying it to the steaming station.

A complete steaming station is illustrated in FIGURES 4*a* and 4*b*; special conveying means interposed between the squeezing rollers and the steaming station, as they are shown in FIGURES 4*a* and 4*b*, can, of course, also be interposed between squeezing rollers **10** and the entry opening for the slubbing at the top of the steaming station shown in FIGURES 1*a* and 1*b*.

Slubbing A coming from the squeezing rollers **10** or from interposed conveying means is introduced into the pre-fixing chamber B through the open top end of the latter.

Pre-fixing chamber B is constituted by a duct of rectangular cross-section and suitable height of about 40 to 100 and preferably about 60 to 80 centimeters. The walls of duct **14** are provided throughout the entire length thereof with perforations or holes **16**. Duct **14** is vertically disposed and is free from any guiding or supporting members for the slubbing, so that the latter, on leaving squeezing rollers **10** can freely enter and pass unimpeded through this duct in downward direction without coming into contact with the walls of the duct. Chamber D is preferably of a length of about 200 to 400 centimeters. The chambers B and D are enclosed in a casing **18**. Duct **14** is spaced from the wall of the casing so as to provide an interspace of rectangular cross-section constituting a chamber C surrounding duct **14** on all four sides. Chamber C is closed at its upper and lower end by walls **20** and thus constitutes a collecting chamber for a heating fluid, preferably steam. Casing **18** is lined with insulating material **22** and bears a dome **24** of semi-circular cross-section vaulted above the open top end of duct **14**, which dome is provided with a rectangular opening **26** through which slubbing A is introduced into pre-fixing chamber B. This opening is provided with inwardly inclined plates **30** which form an entry slot **28**. The width of the latter can be varied by means of an adjustable strip or strips **32** which is or are slidably mounted onto one or both of inclined plates **30**. Thereby, the width of slot **28** can be adjusted to slubbings A of different thicknesses and forms a satisfactory closure for chamber B, whereby excessive loss of steam or the like heating fluid from that chamber to the outside can be avoided.

A preferably horizontally disposed duct **34** is provided in the peripheral wall of casing **18** about chamber C in the central zone of that chamber. The inner wall of this duct separating it from chamber C is provided with a number of apertures **36** establishing communication between chamber C and duct **34**. Furthermore, duct **34** is connected by means of connector-socket **38** to a source of heating fluid, especially saturated steam. The provision of the intermediate chamber C between duct **34** and pre-fixing chamber B prevents direct impingement of a steam-jet from duct **34** onto the slubbing in zone A_1. To the lower open end of duct **14** there is attached a curved deflecting duct **40**, the upper open end of which is of the same cross-section as duct **14**, while the lower open end or discharge opening **42** of this duct **40** is closed by a flap **43** hingedly mounted at the upper rim of opening **42**.

The length of this duct **40** is preferably about equal or slightly longer than that of duct **14**.

In the embodiment of FIGURES 1*a*, 1*b* and 2, the curvature of duct **40** extends through an angle of about 65°, measured along the central curved axis **40***a* of duct **40**. Discharge opening **42** leads to the interior of fixing chamber D in which the final thermal treatment of the slubbing A takes place. This chamber constitutes zone A_2. An endless conveyor **44** which consists of bars secured to two or more endless chains operated by transmission gears **46** is so mounted in chamber D that it passes with its upper reach directly beneath the lower rim of opening **42**; the upper reach of the conveyor is adapted to move first in horizontal direction and then in slightly ascending direction toward the discharge means in front wall **82** of chamber D.

Conveyor **44** extends within chamber D in a substantially horizontal direction, perpendicular to the axis of duct **14**, between sidewalls **47** and is adapted to carry slubbing A. The ascending portion of the upper reach of conveyor **44** is designated by reference numeral **45** and ends adjacent a conveying roller **48** which is flush with an outlet **65**. A couple of driving drums **50** are disposed externally of chamber D and serve to pull the completely fixed slubbing out of the steaming section. Drive means (not shown) are provided to operate these drum means **50** in unison with squeezing rollers **10**. Conveyor gear **49** serves as drive gear and is driven from a motor equipped with a speed control device.

Between rollers **48** and **50**, at the outlet **65**, there is arranged a hydraulic closing device F which acts also as a washing means for the slubbing and which provides a casing **52** (see FIGURE 3) subdivided internally thereof into partitions by tubular separating means **54**, **56**, **58** secured to its side walls to also constitute conveying and guiding members for the slubbing. Separating means **56** and **58** are combined with counter members **57** and **59** respectively.

At the front part of casing **52** above member **54** there is provided a tube **60** which is connected through a connector **62**, with a reservoir containing a suitable liquid, e.g. water; such tube is provided along its generating line with holes **64** venting to a small basin **66** wherein said tube is disposed.

The edge of one of the longitudinal walls of basin **66** is suitably shaped to form a weir **68** and such edge connects through a wall **70** with the periphery of member **57**.

Separating means **56** and **58** form together with the bottom wall of casing **52** a first basin **72** which communicates via separating member **56** acting as a weir, with an adjacent small basin **74** provided with an overflow **76** connected to a drain pipe **78**.

Hydraulic closing device F is provided as a separate member which is detachably secured in the outlet opening **65** of chamber D. For this purpose, its casing **52** has flanges **80** whereby it is fastened, for example by means of screws, to the front wall **82** of chamber D.

Upon the bottom of chamber D and underneath conveyor **44** there is arranged a pipe coil **84** fed with steam through connector **85**. On the bottom of chamber D there is also provided an overflow **86** connected with a drain pipe **88** whereby a liquid level can be maintained in the chamber to form a sump e.g. of water which covers pipe coil **84** if desired. In the present case overflow **86** is also a continuation of drain pipe **78**. Closable drainage means **87** permit emptying of the water sump and introduction of direct steam.

At its upper part chamber D has screens **90** extending towards the duct **40** to form together with the upper walls of said chamber an interspace to avoid dripping of condensed liquid which may form on said walls onto the slubbing on conveyor **44**. The side walls of chamber D are provided with inspection doors **92** to check and control the operations carried out on the slubbing in zone A_2.

In the embodiment of FIGURES 4*a* and 4*b* there is shown a complete pad dyeing apparatus comprising a padding station of known construction, a somewhat modified steaming station according to the invention and a subsequent washing station. In these figures like reference numerals designate like parts as in the embodiment of FIGURES 1*a*, 1*b* and 2; however, several parts have been shown more schematically in FIGURES 4*a* and 4*b*.

Structural differences in the embodiment of the steaming station of FIGURES 4*a* and 4*b* are the following:

In this embodiment, the duct **14** of the pre-fixing cham-

ber B has no heating jacket, it is provided with two inlets **33** and **35** fitted with valves **33***a* and **35***a* respectively, for the direct introduction of steam into the duct **14**. Baffle plates **37** placed over each steam inlet prevent jets of steam or of hot water from impinging directly on the slubbing in zone A_1. Since there is always a possibility, in spite of the lining of insulating material **22**, of condensation occurring in the duct room **14** or of water entering the same via steam inlets **33** and **35**, an annular condensate collecting groove **25** equipped with a drain tube **27** is provided at the lower rim of the dome **24**, about the inlet opening **26**, to gather any condensate that is deposited on the inner wall of the dome.

Furthermore, the hydraulic closing device is replaced by a large conveying roll **51** which serves to convey the completely fixing slubbing to the driving drums **50** past a flexible shield **61** mounted by a hingle **63** at the upper rim of exit opening **65**. Together, conveying roller **51** and flexible shield **61** cooperate to maintain the exit opening **65** sufficiently closed during the operation to prevent undue loss of steam from fixing chamber D.

In FIGURES 4*a* and 4*b*, the padding station comprises not only squeezing rollers **10** shown in FIGURES 1*a* and 1*b*, but also a reservoir **11** for pad-liquor and feeding device through which pad liquor is released to the top side of the pair of squeezing rollers **10**, as well as guide rollers **13** and a large conveying roller **12** which is located above the inlet opening **26** in the dome **24** closing the pre-fixing chamber B.

In the light of the foregoing, the process according to the invention is performed as follows, or in a similar manner:

At the bottom of chamber D there is provided a certain liquid level determined by the fact whether drain **87** is open or closed, and when the latter is the case, by the position of the overflow **86**, while connectors **38** and **85** are fed with steam. Pipe coil **84** is provided with a number of holes **84***a* through which steam is let into chamber D so as to maintain therein the desired conditions of moisture, if any, and temperature. At the same time, through connector **62** a liquid, preferably water, is let into the small basin **66**, which liquid by overflowing along wall **70** of member **57** forms a continuous liquid sheet G ensuring a closure between the interior of chamber D and the outside.

On starting the operation, slubbing A as it emerges from the treating bath, is advanced by squeezing rollers **10** and introduced into chamber B through slot **28**.

Slubbing A moves downwardly under the effect of gravity alone at a suitable speed, determined by that of rollers **10**, into chamber B without coming into contact with the walls thereof and without having to contact any guiding and conveying members but remaining all the time substantially equidistant from said walls.

Steam is let into chamber C through connector **38** and spreads uniformly throughout said chamber and with the same uniformity passes through holes **16** to act upon both faces of slubbing A. Due to the disposition of holes **16**, the thermal action of the steam is effected throughout the entire length and height of chamber B establishing therein determined conditions of treatment (temperature, pressure and humidity) depending on both the nature of the material to be treated and the composition of the treating bath with which slubbing A has been impregnated.

The free movement of the slubbing in chamber B permits the residual treating liquor impregnating the slubbing to spread uniformly throughout the fibrous structure of the slubbing producing an even distribution of the liquor on the fibers. Slubbing A thus becomes uniformly impregnated with the treating solution, while moving through chamber B at a suitable rate of travel.

Slubbing A in its downward movement leaves pre-fixing chamber B proper and enters the deflecting duct **14**.

Due to the specific design of the latter, as the slubbing contacts the curved bottom wall of this duct, it forms superimposed folds extending in planes substantially perpendicular to the direction of travel of the material in chamber B. When a new slubbing first enters with its forward edge this duct **14**, the initial somewhat irregular folds come to rest against flap **43** which is then in closed position under its own weight. As fold is superimposed upon fold, the lower portion of the curved duct is gradually filled, the newly formed folds becoming rapidly uniform and extending substantially across the entire cross-section of the duct in this region. As soon as the weight of the column of folds exceeds that of flap **43**, the flap is pushed open and the folds begin to slide out of the discharge opening **42** onto the moving conveyor belt **44**. The free forward edge of the slubbing is inserted into the hydraulic closing device F and between rollers **50**. Once the operation has been in progress for a short time, the folds will emerge from discharge opening **42** in substantially upright position and remain therein throughout the horizontal stretch of conveyor **44**. As the folds ascend the upwardly inclined stretch of the upper reach of conveyor **44** they begin to tip backward. Consequently, at the upper end of this stretch of the conveyor, the slubbing which is now completely fixed is lifted off the conveyor easily and without any necessity of pulling the web from under a superimposed fold or folds, as would be the case if the folds had been tipped forward instead of backwardly. Forward tipping of the folds which easily occurs if no ascending stretch is provided in the upper reach of the conveyor would lead to frequent tearing of the web.

Flap **43** serves a double purpose, in that, firstly, it prevents development of a "chimney-effect" in the form of a draft from chamber D through ducts **40** and **14**, and, secondly it assists in the beginning of operation with a new slubbing, in the formation of folds of equalized height, i.e. of uniform shape filling well the curved duct **40**. While, in FIGURE 1, there is shown a stage of fold-formation shortly after flap **43** has opened, FIGURES 4*a* and 4*b* show normal filling of duct **40** with flap **43** fully opened. Through the fact that in the beginning of operation flap **43** closes opening **42**, and that during full operation the folds of the slubbing effectively fill the cross-sectional area of duct **40**, steam is prevented from escaping from either one of chambers B and D into the other, and two separate steaming zones with conditions independent in each zone from fluctuations in the other, are maintained in the steaming station at all times.

While the use of flap **43** or a similar mechanical device serving as zone separating means is preferred, the same end can also be achieved to a certain degree by a somewhat narrowed cross-sectional area of the discharge opening **42**.

The weight of flap **43** or mechanical equivalents used in its place should not be too low, for it must be sufficient to cause a certain halt in the downward movement of a newly introduced slubbing descending through duct **40**; on the other hand, it must not be too high lest the column of folds in the duct build up to such height that it reaches the lower region of chamber B, thus leading to unsatisfactory pre-fixing in that region.

While proceeding through chamber D, the folded slubbing or the tow is subjected to the second, final fixing treatment.

Due to the presence of the steam delivered from pipe coil **84** in chamber D, it is possible to establish in that chamber a temperature suitably elevated with respect to that in chamber B; and if necessary, further thermal sources (not shown) may be suitably arranged within this chamber and may be used e.g. when overheated steam is required to fill chamber D.

It is also possible to establish in chamber D predetermined pressure with respect to the outside because of the hydraulic closure formed by liquid sheet G.

After having proceeded along the horizontal portion **44** of the conveyor, the folds are carried onward by the

ascending portion 45 of the upper reach of the conveyor 44 and are lifted up onto roller 48 which straightens the folds and conveys the slubbing in which the dye has been completely fixed to device F without subjecting the same to stretching.

While passing through device F, the slubbing is washed by waterfall G whereupon it passes between rollers 50 which pull it out of the steaming station.

Attention is drawn to the fact that the peripheral speed of outlet rollers 50 is equal to that of inlet rollers 10, whereas the speed of conveyor 44 is adjusted as desired through a speed control. Of course, this speed should be at most equal to the travel rate of the slubbing in chamber B; otherwise fold formation in duct 40 would be impeded.

Change of the speed of conveyor 44 permits varying the form of the folds of the slubbing in zone A_2 and also varying the time during which each fold remains inside chamber D, and consequently the desired total duration of the fixing treatment.

In practice, the time during which the folded slubbing remains in chambers B and D together is varied from a minimum of 3 minutes to a maximum of 45 minutes.

In order to decrease the amount of humidity in chamber D, it is only necessary to lower the level of the liquid therein as determined by the upper end of overflow 86, through opening drain 87.

It is thus possible to secure in chamber D temperatures above 100° C., independent of the temperature prevailing in chamber B, because the outlet of duct 40 is practically closed by both folded slubbing coming out from said duct, and flap 43 striving to close the opening 42.

It is to be understood that the present invention is susceptible of several changes and modifications; for example, internally of chamber B may be disposed other heating sources to increase the action of the steam as let in through connector 38.

The sealing effect at slot 28 prior to the introduction of slubbing A into chamber B may be obtained through suitable sealing members consisting of, for example, rollers.

The apparatus according to the invention avoids the drawbacks of known apparatus. For instance, the excessive height required for J-tube devices is avoided due to the fact that the curved duct 40 can be kept much shorter. On the other hand, it is surprising that complete fixation can be attained in chamber D in spite of the large empty space about the material being fixed, while the attainment of complete fixation is not surprising in the case of a column of material in a narrow J-tube which is built up to a high level.

Another advantage offered by the apparatus according to the invention is the facility of providing a perfectly saturated steam-atmosphere in the large chamber D, since satisfactory fixing requires fully saturated steam which is particularly difficult to maintain with wool. Overheating can be avoided in the fixing chamber D for instance by blowing slightly overheated steam through the water sump in the bottom of that chamber. Superheating of the steam is also possible by the conventional superheating means provided in the apparatus.

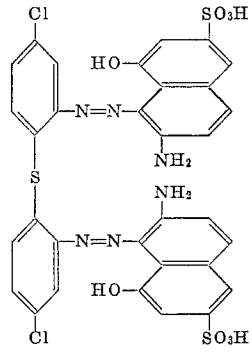
It could also not be foreseen that padded slubbing which had been laid in folds as is the case in zone A_2 in the apparatus according to the invention, could be treated on the conveyor and drawn off without producing undulating color effects. Another advantage of the apparatus according to the invention resides in the fact that the width of the slubbing being treated can be much larger than is the case in the known J-tubes.

A further important advantage of the apparatus according to the invention lies in the avoidance of mechanical stresses on the slubbing being fixed during a stage in which it is particularly susceptible to such stresses. While, in the known J-tubes the folded material must travel with friction on the walls of the tube over a considerable length of the way, such travel with mechanical friction of the folded material is reduced to a fraction, due to the fact that the deflecting duct can be held much shorter, while during the entire treatment with steam in fixing zone A_2, i.e. during the longer of the two fixing periods, the folded material is carried on the conveyor free from any friction or other mechanical stresses. This stress-free treatment helps to avoid undesirable felting of the folded slubbing and yields a finished material which is better spinnable than the material obtained by known steam-treatments.

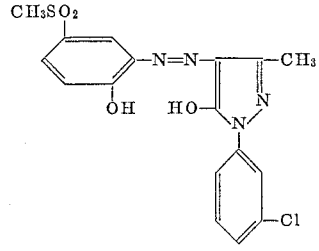
The cleaning of the pre-fixing chamber and the deflecting duct in the apparatus according to the invention is much easier than that of the J-tube.

Example 1.—Wool slubbing, standard color depth 1

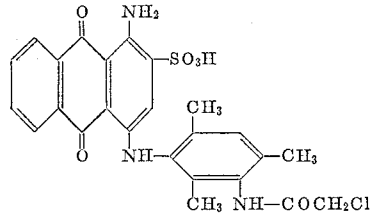
25 parts of a red dyestuff of the formula:



25 parts of an orange chromium complex dyestuff of the formula:



6.25 parts of blue dyestuff of the formula:



are dissolved in 500 parts of hot water and 200 parts of a 5%-aqueous thickener consisting of etherified carob bean gum, and 40 parts of a mixed anionic/non-ionogenic dye assistant consisting of a mixture of 45% of sodium lauryl-diethylenoxy-sulfate, 45% of coconut oil fatty acid N,N bis-ethanol-amide and 10% of isopropanol, are added to the resulting solution. Thereto 100 parts of a 10% formic acid solution are then added and the whole is made up with water to 1000 parts. The temperature should be 40° C.

Wool slubbing is impregnated with the resulting 40° warm solution and squeezed out so as to leave 100% by weight of dye liquor on the slubbing, calculated on the weight of the latter. The slubbing is then treated in the horizontal steam apparatus according to the invention as shown in FIGURE 4, which comprises a 700 mm. high pre-fixing chamber, a curved duct section, the curvature of which describes an angle of about 60° against the vertically disposed central axis of the pre-fixing chamber,

and a subsequently arranged second fixing chamber, which is provided with a conveyor belt, the part of the upper reach of which extends horizontally from the discharge opening of the curved duct section to the discharge means at the end wall of the second fixing chamber, is about 280 cm. long and the upwardly inclined end part of which upper reach is about 45 cm. long and rises at an angle of 34°. The padded slubbing is introduced into the prefixing chamber at a speed of 5 meters per minute without contacting any part of the pre-fixing chamber. The slubbing passes through this chamber under its own weight during 8 seconds without touching any part of the pre-fixing chamber and is subjected therein to saturated steam having a temperature of about 98–100° whereafter the pre-steamed slubbing is laid into folds in the curved duct section. The folded material advances under its own weight towards the exit of the curved portion, the 60° curvature of said portion causing the horizontal folds to be gradually tipped into a near vertical position in which they remain on the upper reach conveyor belt, being transported through the second fixing chamber, for about 20 minutes; when passing upward on the inclined upper reach portion, they are tipped lightly backward upon the succeeding folds, whereby they are easily lifted off the conveyor belt by the discharging roll.

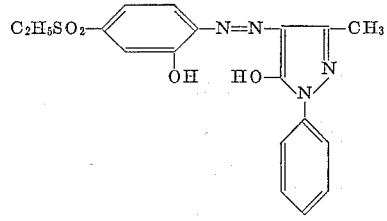
The second fixing chamber is also filled with saturated steam of about 98–100° C., while the folded goods pass therethrough.

Thereafter, the thus treated slubbing is withdrawn from the second fixing chamber, washed with water in the back washing machine and air-dried.

The slubbing is now dyed a uniform, dark red color which shows no "sandwich" effect and is approximately of standard depth 1.

Example 2.—Nylon slubbing—light color

Example 1 is repeated, using nylon 66 slubbing in lieu of wool slubbing, and 5 parts of the chromium dyestuff of the formula:

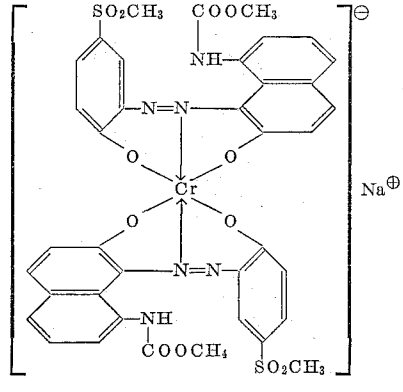


in lieu of the dyestuff used in Example 1. The slubbing passes at a speed of 7 meters per minute through the pre-fixing zone and remains for 10 minutes in the second fixing chamber. Steam conditions in both zones are the same as in Example 1. The color depth is somewhat higher than in the case of Example 1.

Example 3.—Wool slubbing—light color

Example 1 is repeated but the dyestuff used therein is replaced by

5 parts of the dyestuff of the formula



The wool slubbing passes at a rate of 7 meters per minute through the pre-fixing zone and is steamed for 10 minutes in the second fixing chamber. A flawless light grey dyeing is thus obtained.

Example 4

By repeating Example 1, but using instead of the dye assistant used therein 50 parts of a mixture of

35 parts of sodium nonylphenol-diethyleneoxy-sulfate, and

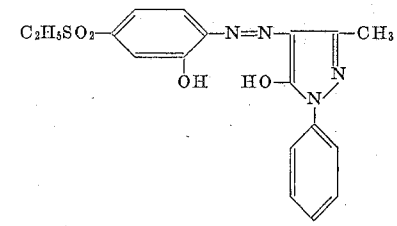
15 parts of coconut oil fatty acid N,N-bis-β-hydroxyethyl-amide, practically the same product is obtained as that of Example 1.

Example 5

By repeating Example 1, but using instead of the dye assistant given therein an equal amount of sodium lauryl sulfonate there is obtained a level dyeing free from sandwich effect and of about 60% greater depth of shade than that of Example 1.

Example 6

20 parts of chromium dyestuff of the formula:



are dissolved in 400 parts of hot water. To the resulting solution are added 200 parts of aqueous 2% carob bean flour solution as thickener and 30 parts of the dye assistant used in Example 1. To the whole are added 200 parts of aqueous 10%-acetic acid and the resulting liquor is diluted to a volume of 1000 parts by the addition of water. The temperature of the liquor is raised to 45°. Nylon 66 slubbing is impregnated with this solution and squeezed out to retain a 110% dye liquor absorption. Then the same steaming procedure as in Example 1 is followed. The material is washed in the back-washing machine in a known way, and then dried.

A very level, well fixed brilliant red dyeing is thus obtained.

Example 7

By repeating Example 6, but using instead of the dye assistant given therein, an equal amount of

35 parts of sodium nonylphenol-diethyleneoxy-sulfate, and

15 parts of coconut oil fatty acid N,N-bis-β-hydroxyethyl-amide and instead of the acetic acid, 20 parts of ammonium sulfate, equally good red dyeings are obtained.

Example 8

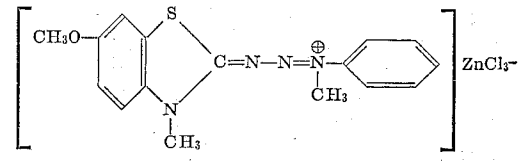
By repeating Example 6, but using instead of the dye assistant given therein an equal amount of the product obtained by condensing, at 150–200°, coconut oil fatty acid and diethanolamin in a molar ratio of 1:2, there are obtained similarly satisfactory level red dyeings.

Example 9

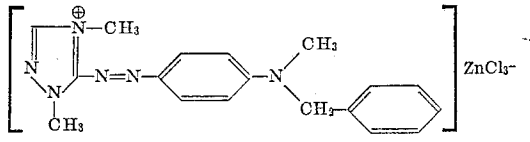
By repeating Example 6, but using instead of nylon 66 slubbing, nylon 66 tow, a level red dyeing is obtained on said tow.

Example 10

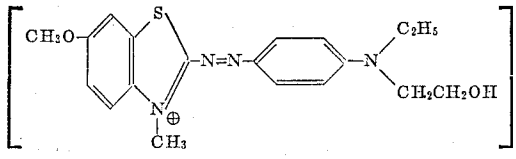
3.5 parts of the dyestuff of the formula



3 parts of the dyestuff of the formula



and 27 parts of the dyestuff of the formula



are mixed with 60 parts of aqueous 80%-acetic acid in the cold to form a paste, which is dissolved in 500 parts of hot water (60°).

200 parts of stock thickener consisting of aqueous 2% carob bean flour solution and 30 parts of the dye assistant used in Example 7 are added.

The whole is diluted to a volume of 1000 parts by the addition of water. The temperature of the liquor is brought to 45°. Polyacrylonitrile tow is impregnated with this solution and squeezed out to retain a 125% dye liquor absorption. The polyacrylonitrile fibers used in this and subsequent examples have a polymerization degree of about 35,000 and contain about 46 millimol of —SO_3H and 17 millimol of —COOH groups per 100 g. of fibers.

The acrylic material is moved at a travel rate of 5 meters per minute through the pre-fixing chamber of the same apparatus as used in Example 1 and then steam treated for 30 minutes in the second fixing chamber, with slightly super-heated steam of a temperature of 104–106° being used in both treatment chambers.

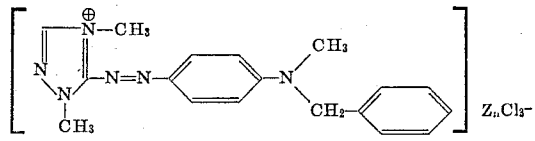
A tow dyed a very satisfactory navy blue shade is obtained.

Example 11

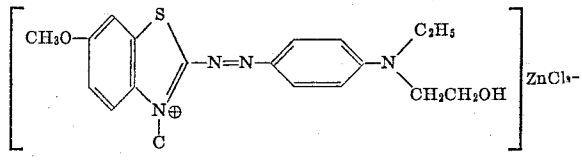
By repeating Example 10, but using in lieu of the dye assistant given therein an equal amount of the product obtained by condensing, at 150°–200°, coconut oil fatty acid and diethanol amine in a molar ratio of 1:2, there is obtained an equally good blue dyeing on polyacrylonitrile tow.

Example 12

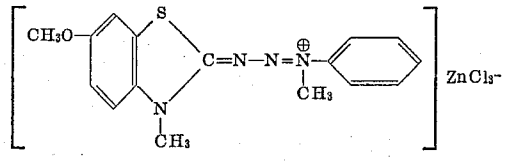
0.54 part of the dyestuff of the formula



0.88 part of the dyestuff of the formula



and 2.1 parts of the dyestuff of the formula



are mixed to a paste with 60 parts of aqueous 80% acetic acid in the cold, and the paste is dissolved in 500 parts of hot water.

200 parts of a stock thickener consisting of aqueous 2% carob bean flour solution and 30 parts of the dye assistant used in Example 7 are added thereto.

The whole is brought up to a volume of 1000 parts by the addition of water and the temperature of the liquor is raised to 45°. Polyacrylonitrile slubbing is impregnated with this solution and squeezed out to retain a 180% dye liquor absorption and then treated in the steam-treating apparatus which is described in Example 1. The travel rate of the slubbing is 7 meters per minute in the pre-fixing zone and it is treated for 15 minutes, slightly super heated steam of a temperature of 104–106° being applied in both zones.

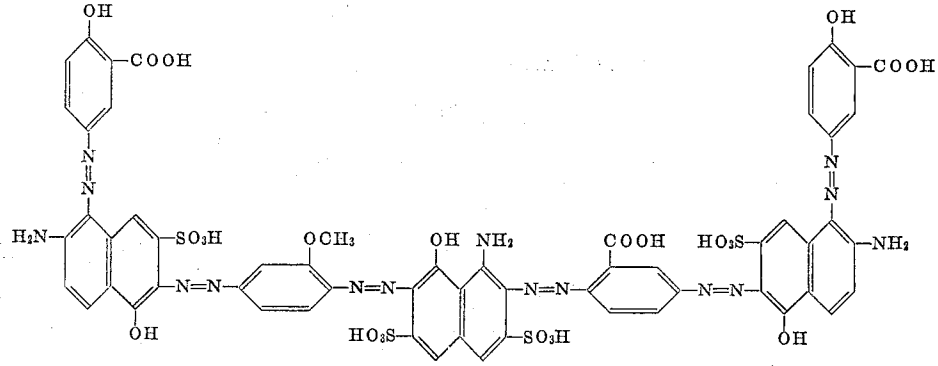
A very saisfactory light tan shade is obtained.

Example 13

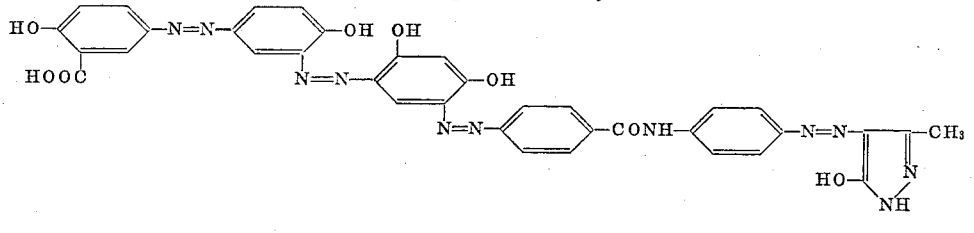
Similar results are obtained when repeating Example 12, but using in lieu of the dye assistant used in that example, the same amount of the dye assistant used in Example 11.

Example 14

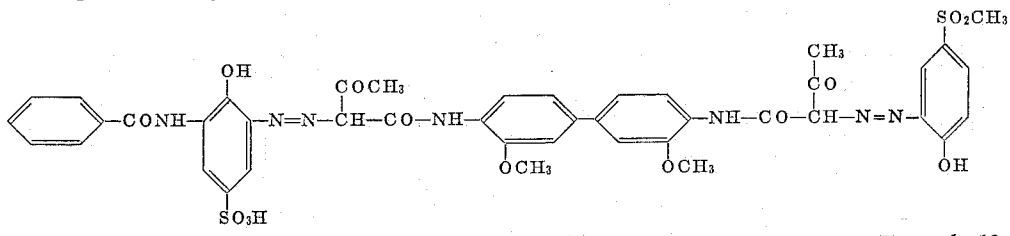
2 parts of the dyestuff of the formula



2 parts of the dyestuff of the formula



and 1 part of the dyestuff of the formula



are dissolved in 250 parts of hot water and mixed with 100 parts of an aqueous 2% carob bean flour thickener stock solution. To the resulting mixture, 5 parts of the dye assistant used in Example 1 are added and the whole is brought up to a volume of 1000 parts by the addition of water. The temperature of the liquor is brought to 45°.

Viscose slubbing is impregnated with this liquor, squeezed out to retain a 100% liquor absorption and then steam-treated in the apparatus which is described in Example 1. In this apparatus, the slubbing has a travel rate of 6.5 meters per minute in the pre-fixing chamber and remains in the second fixing chamber for 15 minutes, saturated steam of a temperature of 98–100° being applied in both treatment chambers.

The slubbing is then treated in the back-washing machine at a speed which allows contact with a coppering bath to last for at least 15 seconds.

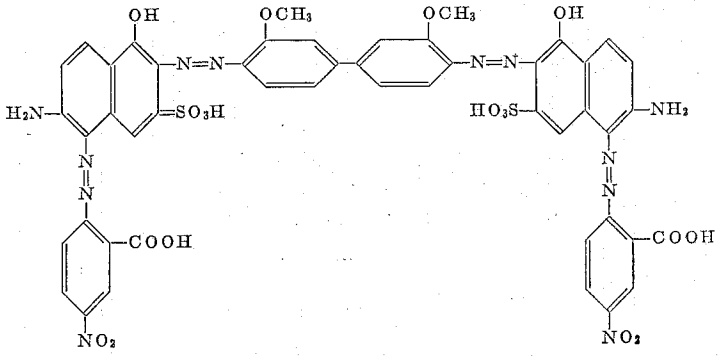
A very satisfactory level light tan shade is obtained.

Example 15

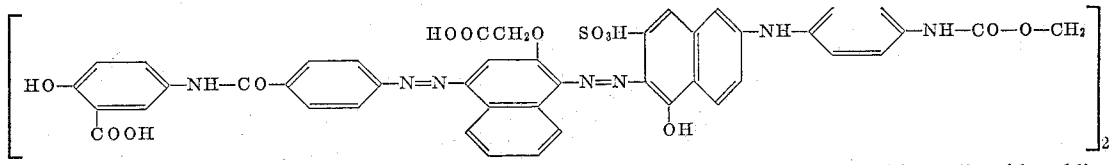
Similar results are obtained by repeating Example 14, but using, in lieu of the dye assistant used therein, 5 parts of the dye assistant used in Example 7.

Example 16

Example 14 is repeated, but instead of the dyestuff blend used therein, 20 parts of a dyestuff of the formula



and 10 parts of the dyestuff of the formula



are used and steam-treated, the goods passing at a rate of 4.5 meters per minute through the pre-fixing chamber and being steamed for 30 minutes in the second fixing chamber; saturated steam of 98–100° is used in both chambers. In all other respects the procedure is the same as that used in Example 14, and similar dyeings of navy blue shade and equally satisfactory properties are obtained as in that example.

Example 17

Example 16 is repeated, but 5 parts of the dye assistant used in Example 7 are used in lieu of the dye assistant used in Example 1. Similar satisfactory results are obtained.

Example 18

Example 14 is repeated, but in lieu of viscose slubbing, viscose tow is dyed, with similar satisfactory results.

Example 19

Viscose tow is dyed by strictly following the procedure of Example 18 but using 5 parts of the dye assistant used in Example 7 in lieu of the dye assistant used in Example 1. Similar results as in Example 18 are obtained.

Example 20

Viscose tow is dyed by strictly following the procedure of Example 16, and goods of similar satisfactory navy blue shade are obtained.

Example 21

Viscose tow is dyed by strictly following the procedure of Example 17, and goods of similar satisfactory navy blue shade are obtained.

I claim:

1. In an apparatus for the continuous padding of slubbings or tow with a dye liquor and continuous fixing of the dye on the slubbings or tow, which apparatus comprises

padding means,

duct means substantially open at both ends, which duct means are disposed beneath said padding means and comprise

an upper section serving as a first fixing chamber, the longitudinal axis of which is in substantially vertical position, and

a lower section, as well as

means connected to said upper section for introducing steam thereinto,

a second fixing chamber being associated with said duct means so that the lower open end of said duct means at the lower section thereof opens into the interior of said second fixing chamber,

and means for introducing steam into said second fixing chamber,

the improvement consisting of means provided at the lower open end of said lower duct section and adapted for cooperating with the slubbings or tow passing through and out of said duct means so as to lay the same into folds and at the same time, together with said slubbing or tow, fill said lower open end and thereby substantially prevent interchange of atmosphere between said duct and said second fixing chamber, while permitting passage of said slubbings or tow in folded form out of said duct means.

2. In an apparatus for the continuous padding of slubbings or tow with a dye liquor and continuous fixing of the dye on the slubbings or tow, which apparatus comprises

padding means,

duct means of substatntially rectangular cross section, open at both ends, which duct means are disposed beneath said padding means and comprise

an upper section serving as a first fixing chamber, the longitudinal axis of which is in substantially vertical position, and

a lower section having a smooth inside surface, as well as,

means connected to said upper section for introducing steam thereinto,

a second fixing chamber having a receiving end and a discharge end and being associated with said duct means so that the lower open end of said duct means at the lower section thereof opens into the interior of said second fixing chamber,

and means for introducing steam into said second fixing chamber,

the improvement consisting of, in combination, said lower section of said duct means being a curved section, the curvature of which corresponds to an angle of about 45 to 90° and the radius of the curved central axis of which is of at least twice the width of said upper section, taken in the same plane as said radius, and

closing means provided at the lower open end of said curved duct section and adapted for cooperating with the slubbings or tow passing through and out of said duct means so as to lay the same into folds and at the same time together with said folds, substantially fill said lower open end and thereby substantially prevent interchange of atmosphere between said duct and said fixing chamber, while permitting passage of said slubbings or tow in folded form out of said duct means.

3. In an apparatus for the continuous padding of slubbings or tow with a dye liquor and continuous fixing of the dye on the slubbings, which apparatus comprises:

padding means,

duct means of substantially rectangular cross section, open at both ends, which duct means are disposed beneath said padding means and comprise

an upper section serving as a first fixing chamber, the longitudinal axis of which is in substantially vertical position, and

a lower section having a smooth inside surface, as well as an inlet opening so located at the top of said upper section and above said lower section that a slubbing or tow issuing from said padding means and introduced through said inlet opening into said upper section is capable of entering said lower section under its own weight, free from other stresses,

first steam-introducing means connected to said upper section for introducing steam thereinto,

and an elongated second fixing chamber having a receiving end and a discharge end and being associated with said duct means so that the lower open end of said duct means at the lower section thereof opens into the interior of said second fixing chamber,

and second steam-introducing means connected to said second fixing chamber for introducing steam thereinto,

the improvement consisting of, in combination, said lower section of said duct means being a curved section, the curvature of which corresponds to an angle of about 45 to 90° and the radius of the curved central axis of which lower section is of at least twice the width of said upper section, taken in the same plane as said radius,

closing means provided at the lower open end of said lower duct section and adapted for cooperating with the slubbings or tow passing through said duct means so as to lay the same into folds and at the same time, together with said slubbings or tow, fill said lower open end and thereby substantially prevent interchange of atmosphere between said duct and said fixing chamber, while permitting passage of said slubbings or tow in folded form out of said duct means,

discharging means mounted at said discharge end of said second fixing chamber adapted for discharging dye-fixed slubbing or tow therefrom, and

conveyor means having an upper reach and being mounted in the interior of said fixing chamber so as to extend with said upper reach directly below the lower open end of said curved duct section and adapted to travel from there in horizontal direction toward said discharge end.

4. An improvement as defined in claim 3 further comprising

humidity and temperature control means associated with at least one of said first and second steam-introducing means adapted for regulating the nature of the steam atmosphere in said first and second fixing chambers, respectively, from substantial saturation to overheating.

5. An improvement as defined in claim 3, wherein the level at which said upper reach of said conveyor means extends in horizontal direction is below the level of said discharging means.

6. An improvement as defined in claim 5, wherein a portion of said upper reach of said conveyor means in the vicinity of said discharge means is inclined upwardly toward the level of said discharge means, over a length and at an angle sufficient to cause the folds of folded slubbing which have been placed on said upper reach at said lower open end of said curved duct section with their folds in substantial vertical position, to tip backward against the direction of travel of said upper reach.

7. An improvement as defined in claim 6, wherein said upwardly inclined portion of said upper reach extends upwardly to a level substantially flush with that of said discharging means.

8. An improvement as defined in claim 6, wherein the upwardly inclined portion of said upper reach extends over about 5 to 15% of the entire length of said upper reach between said lower open end of said curved duct section and said discharge end of said second fixing chamber.

9. An improvement as defined in claim 3 further comprising means for adjusting the rate of travel of said conveyor means from the lower open end of said curved duct section to said discharging means.

10. An improvement as defined in claim 2, wherein said closing means comprise flap means hingedly mounted on the upper rim of said lower open end of said curved duct section.

11. An improvement as defined in claim 10, wherein the weight of said flap means is sufficient to cause a column of folded slubbing or tow filling a substantial part of said curved duct section to build up in the latter while said weight is not so great as to cause such column of folded slubbing or tow to build up into said upper section.

12. An improvement as defined in claim 2, wherein the curvature of said curved duct section corresponds to an angle of 60 to 80°, deviating from the vertically disposed axis of the upper section of said duct means.

13. An improvement as defined in claim 2, wherein the radius of the curvature of said curved duct section does not exceed three times the width of said upper section,

taken in the plane in which said curved central axis is located.

14. An improvement as defined in claim **3**, wherein the upper reach portion of said conveyor means extending from said lower open end of said curved duct to said discharging end is about three to eight times the length of said upper section of said duct means.

15. An improvement as defined in claim **3**, wherein the upper reach portion of said conveyor means extending from said lower open end of said curved duct to said discharging end is about four to five times the length of said upper section of said duct means.

16. An apparatus for the continuous padding of slubbings or tow with a dye liquor and continuous fixing of the dye on the slubbings or tow, comprising

padding means,

duct means of substantially rectangular cross section and open at both ends, which duct means are disposed beneath said padding means and comprise

an upper section serving as a pre-fixing chamber, the longitudinal axis of which is in substantially vertical position, and

a lower curved section having a smooth inside surface, the curvature of which curved section corresponds to an angle of about 45 to 90° and the radius of the curved central duct axis of which lower section is of at least twice the width of said upper section, taken in the plane of said curved central axis, whereby slubbing or tow passing through said upper section and coming into contact with the curved wall of the lower section is laid into substantially uniform folds,

inlet means at said upper section so located above said lower curved section that a slubbing or tow issuing from said padding means is capable of entering said lower section via said upper section and passing therethrough into said lower section under its own weight, free from other stresses,

means connected to said upper section for introducing steam thereinto,

an elongated fixing chamber having a receiving end and a discharge end, and being associated with said duct means so that the lower open end of the curved section of said duct means opens into the interior of said fixing chamber near the receiving end of the latter,

discharging means mounted at said discharge end of said fixing chamber and adapted for discharging dye-fixed slubbing or tow from said fixing chamber,

means for introducing steam into said fixing chamber,

conveyor means having an upper reach and being mounted in the interior of said fixing chamber so as to extend with said upper reach directly below the lower open end of said curved duct section and from there in horizontal direction toward said discharge end of said fixing chamber, and

means provided at the lower open end of said curved duct section and adapted for cooperating with the slubbings or tow passing through said duct means so as to substantially prevent interchange of atmosphere between said duct and said fixing chamber.

17. An apparatus as described in claim **16**, wherein the curvature of the deflecting duct describes an angle of about 60 to 80° relative to the longitudinal axis of said upper duct section.

18. An apparatus as described in claim **16**, wherein the radius of the curved portion of the central duct axis is equal to about two to three times the width of said upper section, taken in the plane defined by said central duct axis.

19. An apparatus as described in claim **16** wherein the length of said elongated fixing chamber is about three to eight times that of said pre-fixing chamber.

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