

Jan. 23, 1945.

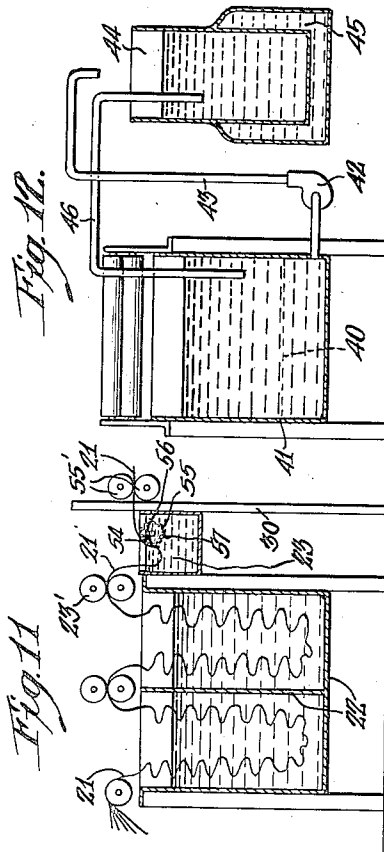
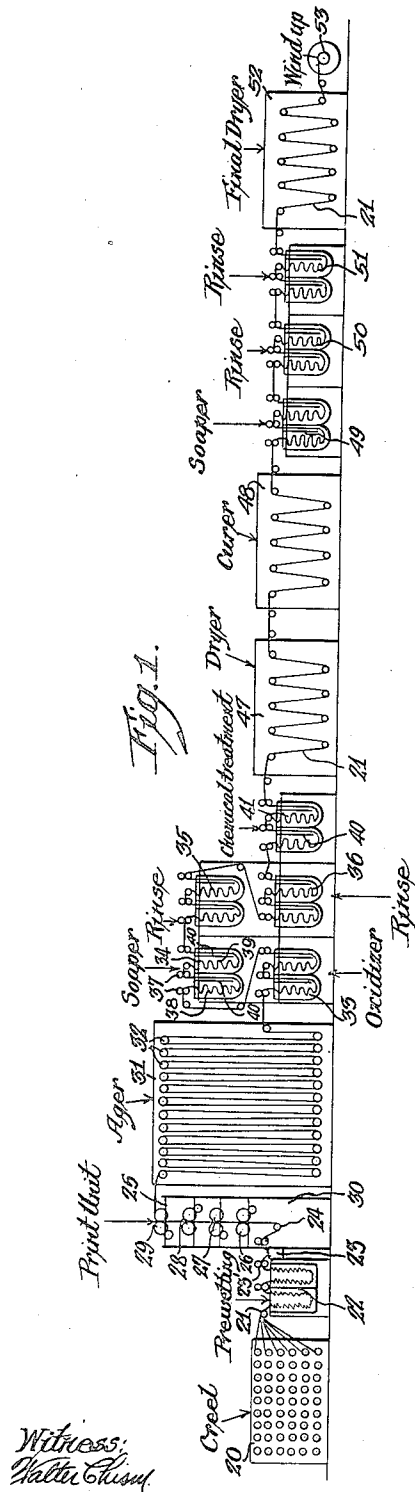
C. H. MASLAND, 2D

2,367,730

TEXTILE DYEING AND FINISHING, METHOD AND PRODUCT

Filed Nov. 20, 1940

5 Sheets-Sheet 1



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TEXTILE DYEING AND FINISHING, METHOD AND PRODUCT

Filed Nov. 20, 1940

5 Sheets-Sheet 2

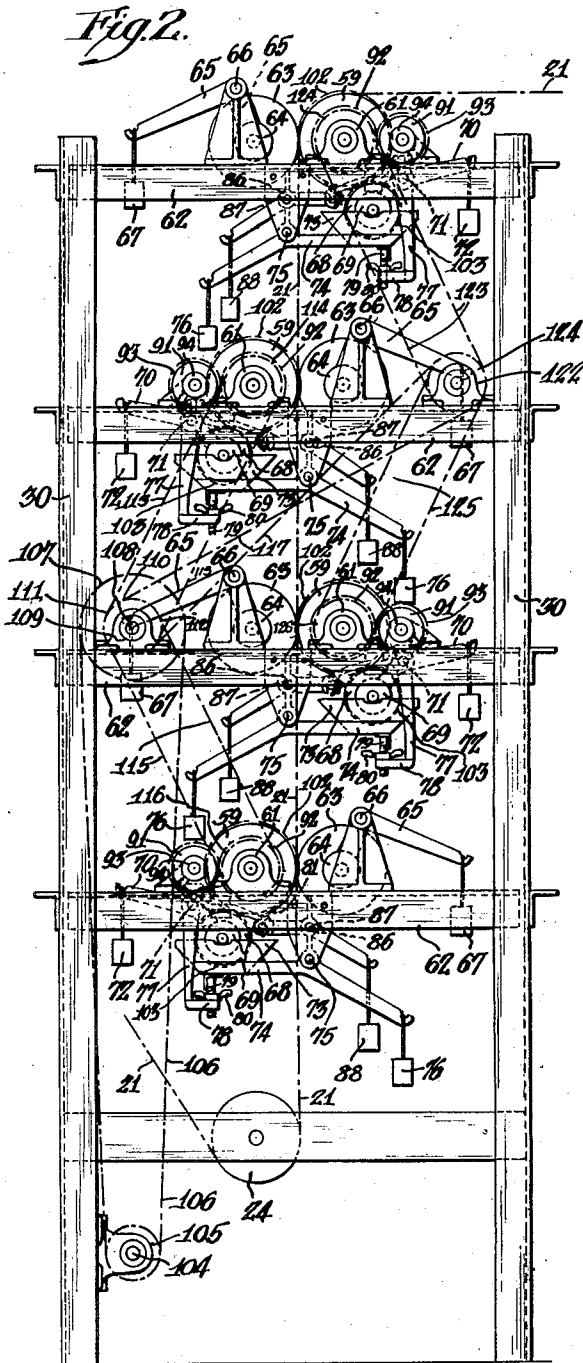


Fig. 7.

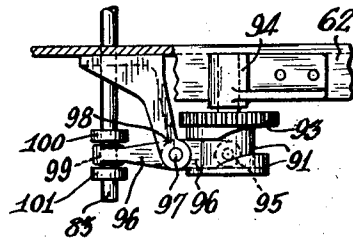
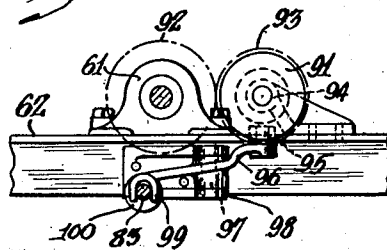


Fig. 6.



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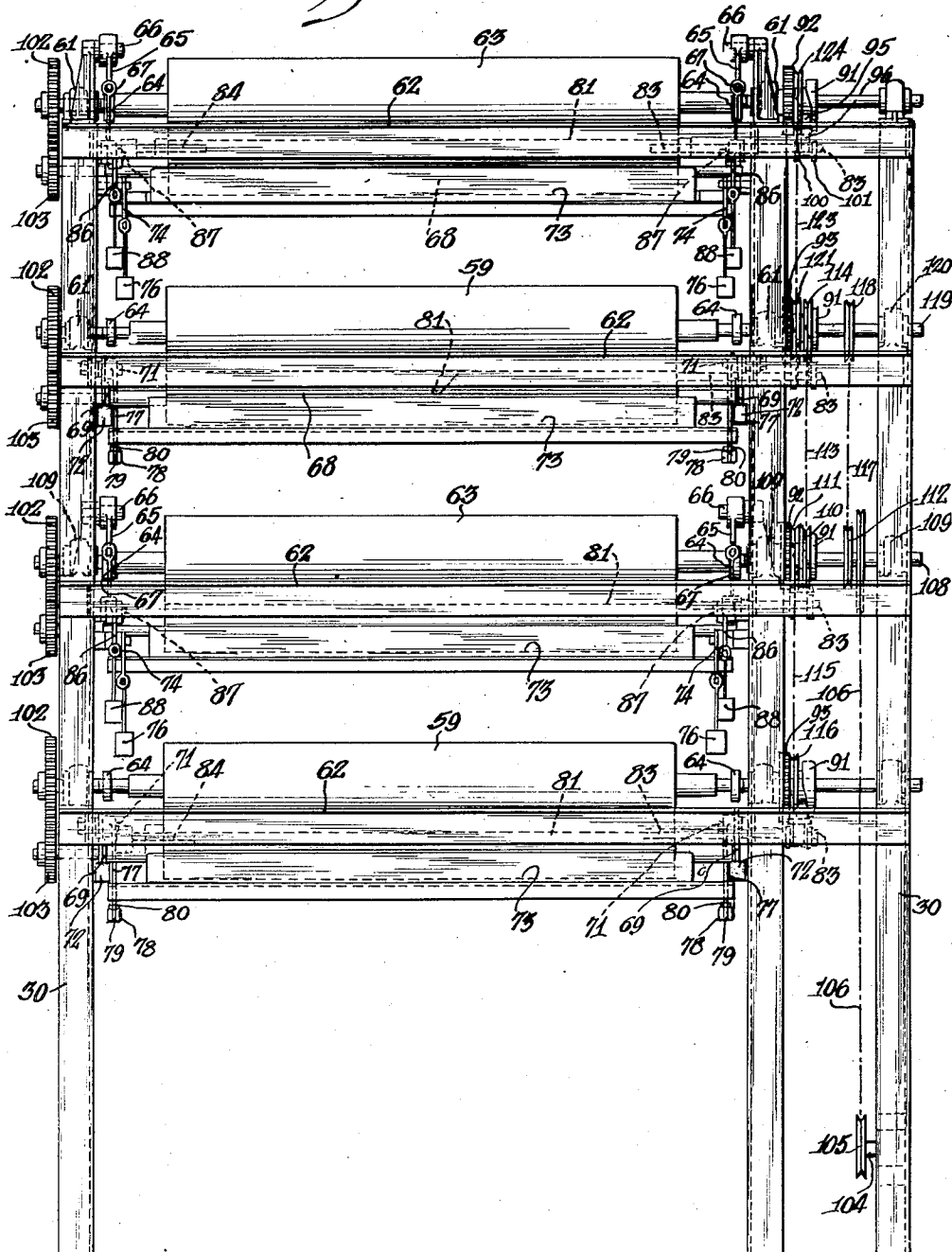
2,367,730

TEXTILE DYEING AND FINISHING, METHOD AND PRODUCT

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5 Sheets-Sheet 3

Fig. 3.



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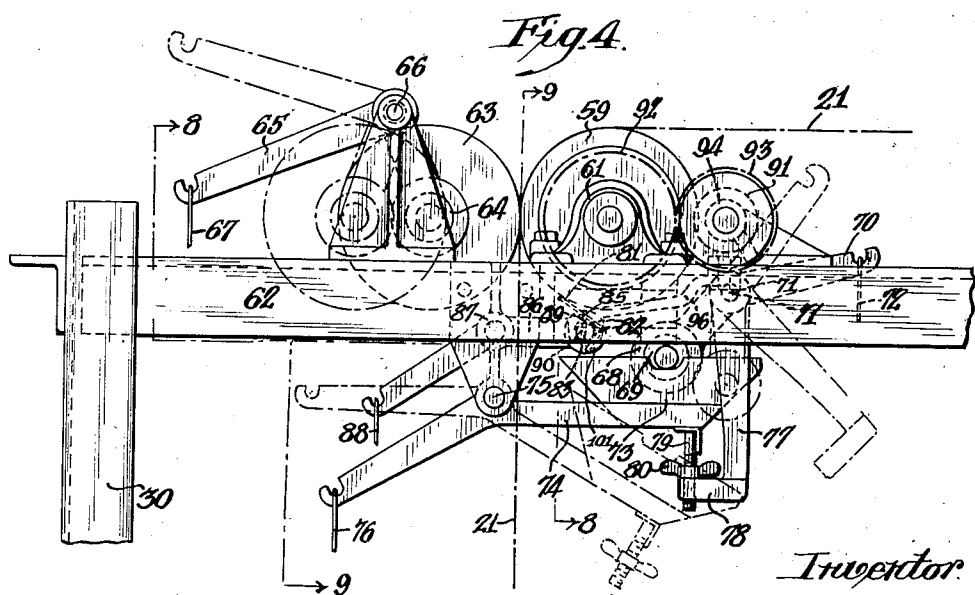
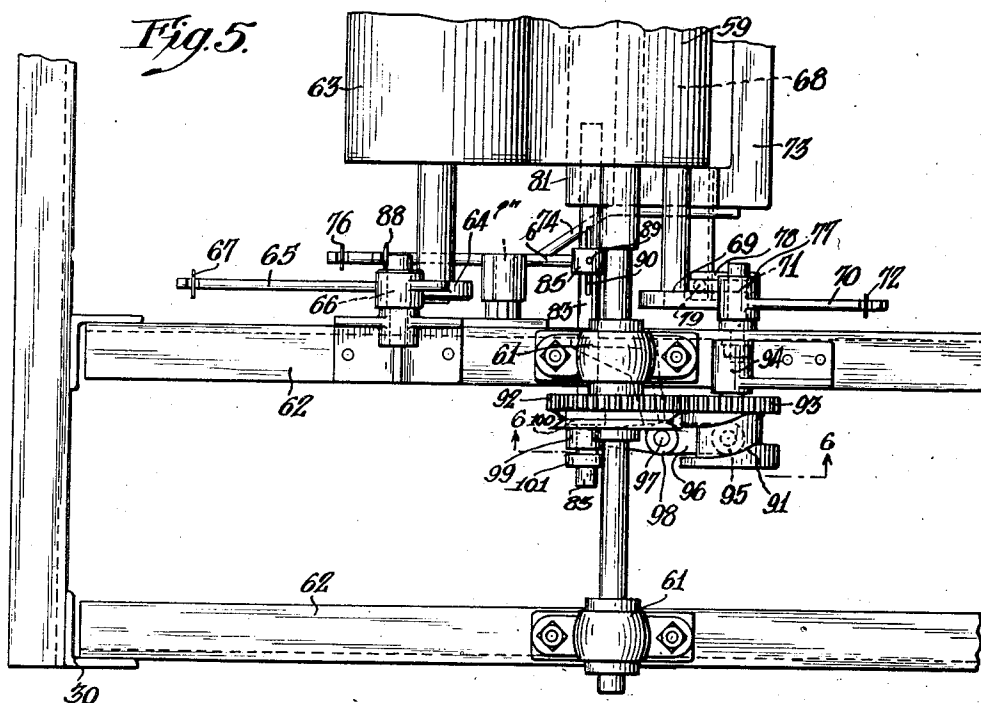
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TEXTILE DYEING AND FINISHING, METHOD AND PRODUCT

Filed Nov. 20, 1940

5 Sheets-Sheet 4



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TEXTILE DYEING AND FINISHING, METHOD AND PRODUCT

Filed Nov. 20, 1940

5 Sheets-Sheet 5

Fig. 8.

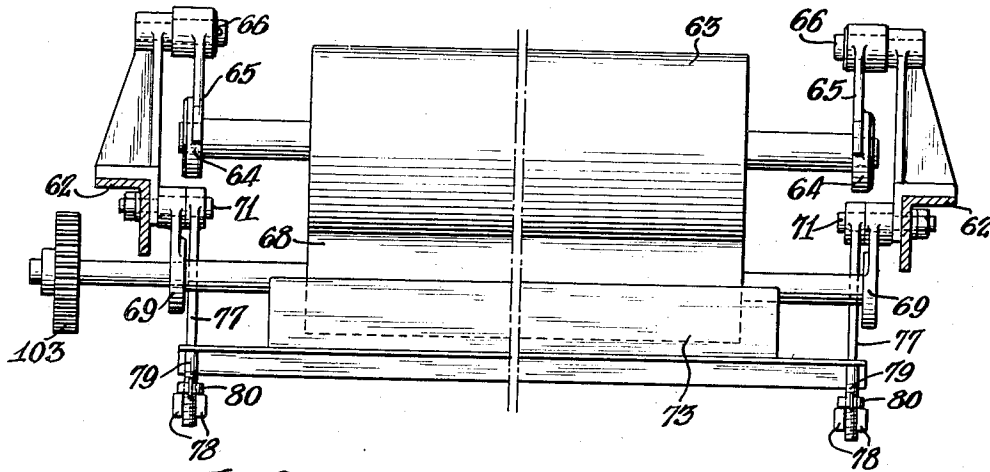
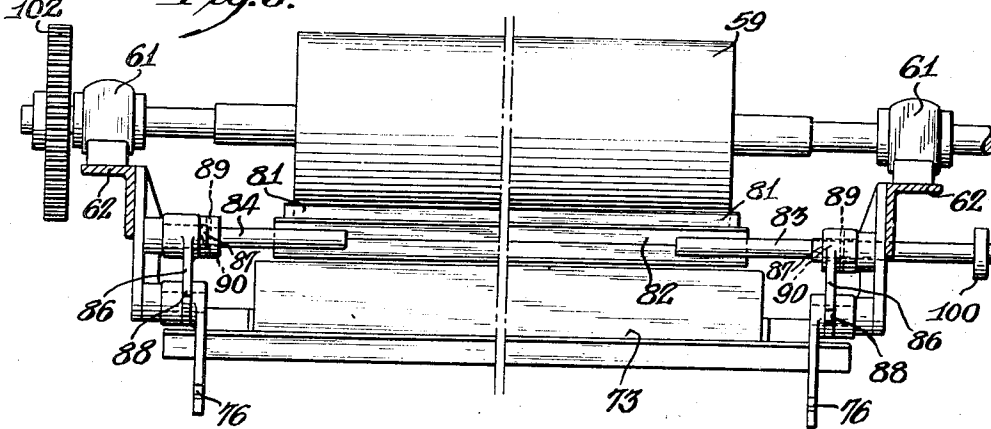


Fig. 9.



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UNITED STATES PATENT OFFICE

2,367,730

TEXTILE DYEING AND FINISHING, METHOD
AND PRODUCT

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Application November 20, 1940, Serial No. 366,354

3 Claims. (Cl. 57—164)

The present invention relates to processes for dyeing, treating, drying, curing and/or manipulating textile fiber, and to the fiber and yarn produced.

The claims directed to the textile dyeing and finishing apparatus have been divided into application Serial No. 408,121, filed August 23, 1941, and the claims directed to the process of making a pile fabric have been divided into application Serial No. 408,122, filed August 23, 1941.

A purpose of the invention is to obtain substantially uniform distribution of solid color on artificial textile fiber which exhibits substantivity, particularly variant substantivity and excessive substantivity.

A further purpose is to supply solid color to artificial textile fiber of excessive substantivity at a rate less than the substantivity.

A further purpose is to fix solid color on artificial textile fiber of variant substantivity or excessive substantivity before redistribution of color under the influence of substantivity can take place.

A further purpose is to dye artificial textile fiber continuously in band form, avoiding the difficulties of batch operation.

A further purpose is to supply solid color to artificial textile fiber of large diameter in volumetrically measured quantities which are proportioned to the length of the fiber or of a flat band containing the fiber, desirably by printing from intaglio-engraved rolls. The measured application of color will in the ordinary case occur on both sides of the fiber band. The color application will desirably take place at a plurality of points on each side of the fiber band.

A further purpose is to size artificial textile fiber continuously and/or render it water-repellent by handling the fiber as an unwoven band.

A further purpose is to progress artificial textile fiber in band form through an aqueous solution of urea formaldehyde, desirably maintained hot and uniform by recirculation from a heated reservoir, and subsequently to dry, cure and wash the fiber, all as a continuous process.

A further purpose is to terminate the drying of artificial textile fiber which has been subjected to treatment with a resinous sizing, at a moisture level of at least 12%, and preferably at least 15% of the dry weight of the fiber, in order to facilitate the spinning of the fiber into yarn.

A further purpose is to apply sizing, desirably urea formaldehyde, prior to spinning, to crimped artificial textile fiber of large diameter in order

to assist in maintaining the crimp during spinning and to obtain greater covering power.

A further purpose is to print color on fiber in band form prior to spinning so that any remaining unevenness of color level may be corrected by drafting incident to spinning.

A further purpose is to print on a fiber band of uniform thickness by passing the fiber band through a liquid, suitably a prewetting bath, removing the fiber band continuously from the liquid by bringing the band while beneath the surface of the liquid into contact with a moving surface, desirably the cylindrical surface of a drum, carrying the fiber band above the surface of the liquid while the fiber band is in contact with the moving surface, preferably draining liquid from the fiber band through openings in the moving surface, flattening out the fiber band desirably by pinch rolls and printing on both sides of the fiber band in flattened form.

Further purposes appear in the specification and in the claims.

In the drawings no attempt has been made to illustrate all forms of the present invention. The single form shown has been chosen because of its convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figure 1 is a diagrammatic front elevation of the preferred form of my novel print-dyeing and chemical-treating device.

Figure 2 is an enlarged front elevation of the print-dyeing unit illustrated in Figure 1.

Figure 3 is a view of the print-dyeing unit of Figure 2 from the left end thereof.

Figure 4 is an enlarged fragmentary front elevation showing the uppermost print dyeing unit of Figure 2.

Figure 5 is a fragmentary top plan view of the uppermost print dyeing unit as seen in Figure 4.

Figure 6 is a fragmentary section of Figure 5 on the line 6—6 thereof.

Figure 7 is a fragmentary plan view of the structure shown in Figure 6 with the supporting angle broken away.

Figure 8 is a fragmentary left end sectional elevation of the printing mechanism shown in Figure 4, with the supporting frame sectioned away, and may be regarded as a section on the line 8—8 of Figure 4.

Figure 9 is a fragmentary section of the print-dyeing mechanism shown in Figure 4 with the press roll and associated structure removed. In position Figure 9 corresponds to the line 9—9 of Figure 4.

Figure 10 is an enlarged fragment of the surface of the intaglio-engraved printing roll.

Figure 10a is a fragmentary section of Figure 10 on the line 10a—10a thereof.

Figure 11 is a diagrammatic side elevation showing the pick-up mechanism 23 which is desirably attached to the prewetting box.

Figure 12 is a diagrammatic illustration of the chemical treatment box and reservoir with associated circulating means. The mechanism of Figure 12 is duplicated with respect to each of the compartments of the chemical treatment box.

In the drawings similar numerals indicate like parts.

Substantivity may be defined as the tendency of a textile fiber to take up dye or the like in preference to the liquid of the dye bath, or in other words, to exhaust the dye bath and lower the dye content in the bath. In the case of natural textile fibers and artificial textile fibers of the comparatively small diameters which have hitherto been commonly used, substantivity has been a comparatively minor factor in uniformity of color level. In the case of artificial textile fibers of large diameter, and particularly those of average diameter between 27 and 75 microns, which are specially suited for house furnishing fabrics of the type of floor coverings and upholstery fabrics, as well as suitings and overcoatings, I find that substantivity becomes a major factor in uniformity of color level. This is particularly true in viscose artificial textile fibers but is also true in other artificial textile fibers such as cuprammonium (which, like viscose, is regenerated cellulose) and casein fibers.

In the first place, in artificial textile fibers of average diameter between 27 and 75 microns, the substantivity is very much more pronounced than in the heretofore common rayons of small diameter. This is true with all dyes, direct as well as vat, but is especially pronounced with vat dyes. This high substantivity causes the fibers to absorb or combine with dyestuffs more rapidly or to a greater extent than they take up the liquid of the dye bath, thus causing progressive variation in the concentration of the dye bath, and, under mass action principles, causing marked variation in dyeing effect upon successive increments of fiber introduced into the dye bath. A second factor which is even more serious than the excessive substantivity of these artificial textile fibers of large diameter is that they exhibit wholly unpredictable marked variations in substantivity from point to point and at frequent intervals, thus producing marked changes in color level unless special precautions are taken. It appears that substantivity variation increases greatly with increase in fiber diameter and out of proportion to the increase in fiber diameter. Substantivity variation in gross artificial textile fibers is exhibited in reference to all dyes—especially vat dyes, but also direct dyes. At the present time efforts to prevent variations in substantivity by changes in the technique of manufacture of the fiber have been unsuccessful when operating in the large diameter fibers.

These two conditions, excessively high substantivity and marked variations in substantivity, have made it impossible to obtain even close approaches to uniform color level by ordinary dyeing processes, such for example, as warp dyeing, skein dyeing, package dyeing and piece dyeing applied to gross artificial fibers of the type of vis-

cose and cuprammonium. Fabrics and yarns comprising large diameter substantive artificial textile fiber which has been dyed by these conventional methods exhibit an unevenness in color level which is at once apparent, and so pronounced as to make it appear that a mottled effect was deliberately sought.

The present inventor has discovered that the difficulties due to variant substantivity and excessive substantivity in substantive artificial textile fibers of large diameter may be avoided by forming the artificial textile fiber into a continuous flat band and applying metered or volumetrically measured quantities of color to successive lengths of the fiber, desirably by printing from intaglio-engraved rolls whose depressions receive and retain a definite measured quantity of color and apply that color to a definite predetermined length of the band of fiber.

The term "band" is used herein to designate unwoven fiber in continuous strip form. The band may either consist of artificial textile fiber in the form of a rope or bundle obtained from the filament extrusion machine after suitable treatment such as desulphurizing, bleaching and washing, or it may consist of a sliver coming from a raw preparation process such as carding, combing or gilling, or it may be a warp or warp unit of several yarn ends. The rope, bundle, sliver or warp may come directly and continuously from the mechanism on which it was prepared or it may come rolled into a spool, ball, cake, roll, cheese or rolled warp.

It is considered that the best application of the invention will be to ropes or bundles of substantive continuous filament which are not to be converted into staple fiber until after treatment by the present process, and to warps.

While the widest application of the invention is believed to be to substantive artificial textile fiber of average diameter between 27 and 75 microns, certain features of the invention may also be applied to substantive artificial textile fiber of smaller or larger deniers and to wool of all deniers, particularly carpet wool, as well as other natural fibers which exhibit substantivity.

By the processes of the invention, each unit length of fiber in band form receives an equal measured amount of color on each side of the band. It is usually desirable to make several (at least two) applications of measured quantities of color to each unit length of a particular side of the band of fiber. In the preferred form of the invention this is accomplished by printing first on one side, then on the second side, then again on the one side and finally again on the second side.

The color used is desirably in the form of a viscous liquid or paste dye which can readily be printed in measured quantities on both sides of the fiber band progressively as the band advances. When the term "solid color" is used in this application, it is not intended to refer to the viscosity of the color, that is, it does not indicate whether or not the color is non-liquid in form; the term "solid color" indicates that, in any given case, the color is all of one tone.

The measured quantities of color are desirably predetermined to be below the quantity required by the substantivity of the particular length of the fiber band to which the color is to be applied. Thus, in the ordinary case there remains, even after the printing application, an unsatisfied substantivity which does no harm to

the color level because it does not encounter available color to take up.

The feature of supplying color at a rate below the substantivity of the fiber in the case of these fibers of excessively high substantivity is particularly important in the case of deep shades such as black or magenta. Of course, if the quantity of color supplied at a particular point exceeded the substantivity, whereas the quantity supplied at other points was below the substantivity, there would be abnormal loss of color in washing at the point where the substantivity was exceeded and unevenness in color level would result. It is, therefore, best to operate at all times below the substantivity of the fiber.

Where there is variation in the substantivity, this unsatisfied substantivity will vary along the length of the fiber but will do no harm because it does not encounter additional color, the amount of color supplied to each unit length being metered and equal.

In order to obtain the full advantage of the invention, the color should be fixed immediately after it is applied so that there will not be any substantial opportunity for color to flow in the fiber band from a point of comparatively low substantivity to a point of comparatively high substantivity, thus rendering the color level uneven.

The intaglio-engraved rolls employed in the present invention are engraved all over and not merely engraved in certain places as in the case of rolls used for printing pattern effects.

It is quite important in the present invention to maintain volumetric control over the color application to the band of fibers, and this is possible with an engraved roll having depressions of definite size and a doctor blade which ensures that the color merely fills the depressions. This accurate control is not possible with padding where a smooth or absorbent roll picks up a variant amount of color, depending on the viscosity of the dye, the absorbability of the fibers and various other conditions. Likewise, no volumetric control of color application can be obtained where the fibers are carried through the reservoir of color paste.

While the present invention's method of control of color application is volumetric, it will be understood that, given uniform density, volumetric control will necessarily result in control over weight, and volumetric uniformity of distribution will mean uniformity of distribution by weight.

After the printing of color upon the fiber band, the color will be desirably immediately fixed, the method of fixing depending upon the particular dye used. Ordinarily the fiber band will pass directly through an ager or steamer in which it will be exposed to steam at a temperature depending upon the dyestuff, suitably 212° to 215° F. for a time of 4 to 5 minutes in the case of a vat dye, and at a somewhat lower temperature for a longer time, for instance 180° to 190° F. for 8 to 10 minutes, in the case of a direct or acid dye. The finishing treatment of the dye will vary with the dyestuff as well known in the art. For example, with a vat dyestuff the treatment may consist of oxidizing with an oxidizing agent such as hydrogen peroxide and then passing through hot soap solution while in the case of a direct or acid dye there would normally be treatment with cold neutral soap solution followed by a rinse.

From the standpoint of convenience and manu-

facturing economy, it is very desirable to proceed with further chemical treatment directly upon the fiber band after it leaves the printing mechanism and its associated fixing units.

Where sizing is to be applied on unspun fiber there is a further important advantage in proceeding at once with the sizing or finish coating. During the printing, the steaming in the ager and the treatment in the fixing baths, certain opportunities develop for crimping forces to become effective. Also in many cases the fiber initially supplied to the printing device will have been previously crimped, for example, by the rayon manufacturer. Whatever the source of the crimping, whether previously deliberately applied or incidental to the operations performed herein, it is very desirable that crimping be preserved for its advantages during spinning and for its effect upon the final yarn and fabric.

Application of sizing prior to spinning assures that the effect of the sizing or finish coating will be present during spinning to maintain the crimp, whereas this is not true if the sizing is not applied until after the spinning of the fiber into yarn. Furthermore, if sizing is applied before spinning, the sizing will increase the covering power by setting the fiber in its unspun condition, so that after spinning the fibers will tend to untwist, thus forming a loftier yarn of greater covering power.

The application of the urea formaldehyde or other resinous sizing before spinning is very important where the fibers are to be employed in the pile of a pile fabric such as a carpet or rug. The stable condition of the fibers is the condition reached after the resinous sizing is cured, and the fibers tend to return to their unspun condition in the cut pile to a much greater degree than when the fibers are untreated or treated by any other method, thus assuring increased loftiness in the pile. There is a further advantage of applying the color and the sizing to the fiber in unspun condition. Although the print dyeing removes all pronounced unevenness in color level, drafting subsequent to print dyeing has the effect of eliminating any slight irregularities in color level which may nevertheless remain, and also enables color corrections to be made in the entire lot after a sample has been run.

For these and other reasons it is very desirable to proceed directly with the sizing or other desired chemical treatment as a step following the print dyeing during the continuous travel of the band. Less advantageously, however, the sizing or other chemical treatment can precede the print dyeing. It will also be understood that even where print dyeing is not being employed, continuous sizing or chemical treatment in accordance with the present processes may desirably be used.

In the present invention it is preferred to employ urea formaldehyde, although any other suitable resinous sizing such as thiourea formaldehyde, phenol formaldehyde, or the like might be employed and the disclosure of resinous sizing herein is generic. Urea formaldehyde is much superior to other resinous sizings.

The resinous sizing, for example urea formaldehyde, desirably serves to maintain crimp as previously explained. The urea formaldehyde also tends to make the pile fibers of cut pile fabrics return to or approach their unspun condition as previously explained, imparting loftiness.

Unless precautions are taken in applying the urea formaldehyde, it will penetrate the fibers

and markedly increase the brittleness. To prevent such increase in brittleness, I will preferably use only urea formaldehyde in an advanced stage of polymerization, in which condition the resin will not penetrate but merely coat the fibers, and will not increase the brittleness.

Urea formaldehyde may desirably be applied to the fiber in an aqueous treating bath by passing the band of fiber through the bath. The preparation of the liquid resin (or the unpolymerized liquid mixture of resin ingredients) will preferably be as follows:

Formaldehyde and urea in proportions of about 1.8 molecular quantities of formaldehyde to 1.0 molecular quantity of urea are brought together at about 130° F. in a suitable quantity of water and in the absence of a catalyst. A pH of about 9 is maintained. When the product is condensed to the desired degree, a suitable catalyst such as ammonium acid phosphate is added and the resultant product is ready for application to the textile fiber. A treating temperature of 90 to 110° F. is recommended.

It is not ordinarily desirable to employ more than 5% of urea formaldehyde on the weight of the fiber. Up to 5% of urea formaldehyde on the weight of the fiber may be employed without embrittlement if care is taken to see that the urea formaldehyde coats without penetration.

In addition to the sizing, other suitable chemical treatments may be applied in the same bath or in a separate bath, such as finish coating, delustering, lubricating and waterproofing.

A special after treatment is employed to fix or "cure" the urea formaldehyde. The after treatment used will ordinarily be as follows:

1. Drying
2. Curing
3. Washing
4. Drying

The initial drying will desirably be accomplished at a wet-bulb temperature not in excess of 120° F. (the temperature of the moisture on the fiber). In the initial drying, the fiber should reach practical dryness, that is 3% moisture or less on the weight of the fiber. The curing temperature should range between 270° and 300° F., with the time in inverse rate. About 10 minutes curing at 270° F. or 5 minutes curing at 300° F. gives satisfactory results.

The reasons for having the fiber practically dry before elevating the temperature for curing are to avoid fiber degradation effects of the acid and also to remove excess formaldehyde which, if present on the fiber at high temperature, tends toward an embrittling effect.

After curing, the fiber is washed with water to remove products of decomposition resulting from the curing. The washed product is then dried at the most economical temperature, preferably about 212° F. wet bulb and 250° F. dry bulb.

Where the product under treatment is unspun fiber, the moisture content at the completion of the final drying operation is a matter of importance. When the product comes from the drier in substantially dry form and is subsequently converted into yarn by cutting into staple fiber lengths, if not already cut, drafting and spinning, it has been found that the fiber produced in accordance with the invention is difficult to manipulate. Where the treatment with urea formaldehyde as above described has been

used, the fiber, if substantially dry, behaves like wire in carding and is practically unspinnable in that form. Lubrication with oil or with emulsion, and ordinary types of moisture treatment such as sprinkling or exposure to moisture for a few hours are of no benefit.

This condition can be corrected by exposure to moisture at room temperature for 36 to 48 hours, with some reduction in time if elevated temperatures are used. The present inventor has discovered, however, that the whole difficulty can be avoided and the material rendered immediately and normally spinnable on either the woolen or the worsted system, if the drying operation be terminated when the moisture content has been reduced to not less than 12%, and preferably not less than 15% of the dry weight of the fiber. The upper limit of moisture content will normally be 30% and preferably 25% of the dry weight of the fiber.

The advantages concerning sizing with resin given in this application would in general apply not only to the artificial fibers for which it is chiefly intended, but, to a less pronounced extent to comparable fibers of wool, lute, etc. The methods of sizing with resin for the natural fibers would be similar.

The fiber band after completion of the print dyeing and sizing as continuous steps, may be subsequently manipulated in any manner desired. If the fiber is in the form of a bundle or rope of continuous filament, it will normally be cut into staple lengths, drafted and spun. If the fiber already is in the form of a sliver or roving of staple fiber, it will be drafted and spun. The fiber treated herein may be blended with any other suitable fiber as desired. If the fiber is in the form of a warp or warp unit, it may be used directly for weaving or other procedure of producing fabric (for example, by cementing to a backing for production of a cemented pile fabric). The yarn may also be plied to combine several ends.

In the apparatus as shown in Figure 1, the material undergoing treatment is drawn from any suitable source here illustrated as a creel 20. The raw material is drawn off in the form of a band and may, as already explained, actually be a rope, bundle, roving, sliver, warp, or the like. The band 21 may be printed dry but will ordinarily undergo prewetting in the treatment box 22 from which it is withdrawn by a pick-up mechanism 23, later to be described, which assists in forming a flat band. A considerable quantity of band will normally remain fan-folded in the treatment box 22, being drawn out at a rate determined by the speed of movement of the rolls 23', which are operated by means not shown synchronized with the printing rolls. The prewetting box in the case of rayon will normally merely contain water, but in the case of wool a scouring agent followed by a suitable rinse may be employed at this point. From the treatment box 22 the flat band 21 is carried over an idler 24 to the printing mechanism 25 consisting of printing units 26, 27, 28, and 29 arranged one above another on a frame 30.

The printing units 26 and 28 print on the right-hand side of the upwardly directed span of fiber band shown in Figure 1, while the printing units 27 and 29 print on the left-hand side of this span. From the printer 25 the fiber band proceeds to dye-fixing mechanism starting with an ager or steamer 31 of any suitable well-known type provided with guide rolls 32, driven in any

suitable manner, and normally supplied with steam by means not shown.

As already explained the character of the fixing treatment will depend upon the dye used. In this example the fiber band passes from the ager successively through an oxidizer 33, a soaper 34, and rinses 35 and 36. Each of these treatment boxes 33 to 36 may be of any well-known type, and here are provided with feed rolls 37, driven in any suitable manner and carrying the fiber band between compartments 38 and 39, each of which has a partition 40 separating the outgoing from the incoming portions of the fiber band.

From the dye-fixing mechanism the fiber band is progressed to the sizing box 41 in which urea formaldehyde is contained in solution or suspension. The most efficient temperature of operation in the treatment box 41 is from 90 to 110° F. To maintain this temperature and to maintain uniformity of the treating liquor, the treating liquor in each compartment of the treatment box 41 is continuously drawn off at a pump 42 (Figure 12) and connections 43 to a reservoir 44, jacketed at 45 by hot water. The reservoir 44 contains urea formaldehyde of the same composition as that in the treatment box. Treating liquor continuously flows through the pipe connection 46 to the compartments of the treating box. The fresh treating liquor from the reservoir 44 is introduced by the pipe 46 on the outgoing side of each compartment of the treatment box 41, thus applying the countercurrent principle.

From the treating box 41 the fiber band desirably passes through a drier 47 of any suitable type and heated by any suitable means, not shown. The drier will normally operate at a temperature not exceeding 120° F. wet bulb. From the drier 47 the fiber band progresses to a curer 48 maintained at a more elevated temperature, suitably between 270° F. and 300° F. dry bulb. From the curer 48 the fiber band passes through suitable washing units, desirably consisting of a soaper 49 and rinsing boxes 50 and 51. From the washing units the fiber band is carried to a drier 52 operated at the most economical temperature, preferably about 212° F. wet bulb and 250° F. dry bulb. The fiber is withdrawn from the drier 52 before its moisture content has dropped below about 12% and preferably before it has dropped below 15% of the dry weight of the fiber. From the drier 52 the fiber band passes to any suitable take-up mechanism, here shown as a windup 53, or directly to a preparation or spinning apparatus.

Special precautions are taken to insure that the fiber band which comes to the printing mechanism is substantially of uniform thickness. If the fiber band were withdrawn from the liquid without taking any precaution in this respect, the effect of the surface tension of the liquid would result in producing a circular or oval cross section of the band and the flattening action of the flattening rolls would produce a band much denser or thicker at the center than at the edges. To prevent this a pick-up mechanism 23 is employed, best seen in Figure 11. Beneath the surface of the liquid in the pick-up mechanism 23, the fiber band is carried into contact with the moving surface 54 of a drum 55. It will be noted that the point of contact 56 with the drum 55 is below the surface of the liquid. At the time contact between the fiber band and the surface of the drum is made, the fiber band is relatively

spread out due to the action of the liquid. The spread fiber band is then carried up over the upper surface of the drum until it is above the surface of the liquid, adhesion to the surface of the drum overcoming the tendency of the fiber band to assume a circular or oval cross section when leaving the liquid. The drum surface is desirably of metallic screen wire 57 or other foraminated material so that liquid from the fiber band will drain through the drum as the band travels with the drum. The point at which the fiber band leaves the drum is well above the surface of the liquid. After leaving the drum the fiber band is flattened by pinch rolls 55', and then is printed on both sides by the printing mechanism.

The printing mechanism is best seen in Figures 3 to 10, inclusive.

The printing units 26 to 29 inclusive each include an intaglio engraved printing roll 59, suitably of copper. The roll 59, as best seen in Figures 10 and 10a, has channels 60 extending over its entire surface. These channels are preferably set at an angle of approximately 45° to the axis of the roll as shown. Each channel is substantially identical and, when the printing roll is engaged by the furnishing roll and wiped by the doctor blade, each channel 60 contains substantially the same measured quantity of color. In printing artificial textile fiber of large diameter, it has been found to be desirable to employ channels approximately ten-thousandths of an inch deep, and to use twenty-eight channels per inch on the circumference of the roll. It is not, however, intended to limit to these dimensions, but merely to state them by way of example.

Each printing roll 59 is mounted in fixed bearings 61 on horizontal portions 62 of the frame 30. The fiber band 21 engages the surface of each printing roll 59 and the opposite surface of the fiber band is engaged by a press roll 63, suitably of rubber or other resilient material, rotating in bearings 64. The bearings 64 form the ends of bell cranks 65 which are pivoted at 66 and which carry, at the ends distant from the bearings 64, weights 67 whose size determines the pressure of the press roll 63 against the printing roll. The press roll 63 may be swung from its operative position to its inoperative position when a new fiber band is to be threaded through the machine.

The printing roll 59 is normally engaged by a furnishing roll 68 of rubber or metal which rotates in bearings 69 forming the ends of bell cranks 70 which are pivoted at 71 and whose distant ends carry weights 72 determining the pressure of the furnishing roll against the printing roll. The lower edge of the furnishing roll 68 dips into dye within the trough-like color reservoir 73 pivotally supported on bell cranks 74 which are pivoted at 75 and counterweighted at 76. The position of the color reservoir 73 is adjustably determined by depending arms 77 pivoted at 71 and having claw extensions 78, which engage and lie on each side of studs 79 secured to the lower portion of the color reservoir. Adjustment of the position of the color reservoir is made by thumb nuts 80.

Engaging the printing roll 59 at its lower side between the furnishing roll and the press roll, there is a doctor blade 81, supported on an angle 82 fixed to stub shafts 83 and 84, which extend through sliding bearings 85 in the ends of bell cranks 86 pivoted at 87 and carrying weights

88 determining the pressure on the doctor blade. The stub shafts 83 and 84 have longitudinal freedom of motion in the bearings 85, and are prevented from rotating by the engagement of pins 89 extending inwardly at the bearings 85 and engaging in slots 90.

Longitudinal reciprocating motion of the doctor blade is secured by a cam 91 driven from the printing roll shaft by a gear 92 driving a gear 93 preferably integral with the cam. The cam rotates in a bearing 94. The cam follower 95 is on the end of a lever 96 pivoted at 97 in bearing 98 and the opposite end of the lever carries a socket 99 which in operative position engages and surrounds the stub shaft 83 between the collars 100 and 101. Thus as the printing roll turns, the cam 91 produces lateral reciprocation of the doctor blade.

When the doctor blade is moved into inoperative position about the pivot 87, the shaft 83 leaves its position of engagement with the socket 99, returning to proper position when the bell cranks 86 are rocked to their normal operative position.

In each printing unit the printing roll is driven directly, the press roll idles, and the furnishing roll is driven from the printing roll by interconnecting gears 102 and 103. The press rolls are driven by a main drive shaft 104 having a pulley 105 connected by a belt 106 to a pulley 107 on a shaft 108 turning in bearings 109. The shaft 108 carries three driven pulleys 110, 111 and 112. The pulley 110 connects by a belt 113 to a pulley 114 on the shaft of the third printing roll (counting from the bottom). The pulley 111 connects by a belt 115 to a pulley 116 on the shaft of the first or lowermost printing roll. The pulley 112 connects by a crossed belt 117 to a pulley 118 on a shaft 119 in bearings 120. The shaft 119 also carries pulleys 121 and 122. The pulley 121 connects by a belt 123 to a pulley 124 on the shaft of the fourth or upper printing roll and the pulley 122 connects by a belt 125 to a pulley 126 on the second printing roll.

It will be evident that in all cases the printing rolls are rotated so as to carry the fiber band upward.

In operation the fiber band is carried between the respective printing rolls and press rolls and the press rolls are moved into their pressure position against the printing rolls.

The furnishing rolls and doctor blades are likewise moved into engagement with the press rolls and the color reservoirs are positioned and filled

with dye paste or the like. The fiber band is carried through the other units of the mechanism including the washing and treating boxes, and the driers and curer.

I believe that I am the first to apply solid color to both sides of a fiber band in quantities volumetrically related to the length of the band.

I also believe that I am the first continuously to print and size a travelling fiber band.

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

Having thus described my invention, what I claim is new and desire to secure by Letters Patent is:

1. The process of producing yarn, which comprises forming textile fiber into a continuous band, uniform in thickness, of unspun fibers, applying equal volumetrically measured quantities of solid color in fluid form to successive equal lengths on both sides of the band, continuously applying sizing to the fibers of the band and, subsequently to the application of the color and of the sizing, spinning the fibers into yarn with accompanying drafting.

2. The process of producing yarn, which comprises forming a continuous flat band of unspun artificial textile fibers, continuously applying solid color in fluid form to both sides of the band by intaglio printing, fixing the color on the fibers, continuously applying resinous sizing to the fibers, fixing the resinous sizing on the fibers and subsequently spinning the fibers with accompanying drafting, the steps being performed in the order named, thereby the sizing aids in maintaining any crimp during spinning and the subsequent spinning corrects any differences in color level.

3. The process of producing yarn, which comprises forming a continuous flat band of unspun textile fibers, applying solid color in fluid form to the fibers of the band by intaglio printing on both sides of the band, fixing the color, applying urea formaldehyde to the fibers of the band, fixing the urea formaldehyde and subsequently spinning the fibers into yarn with accompanying drafting.

CHARLES H. MASLAND, 2ND.