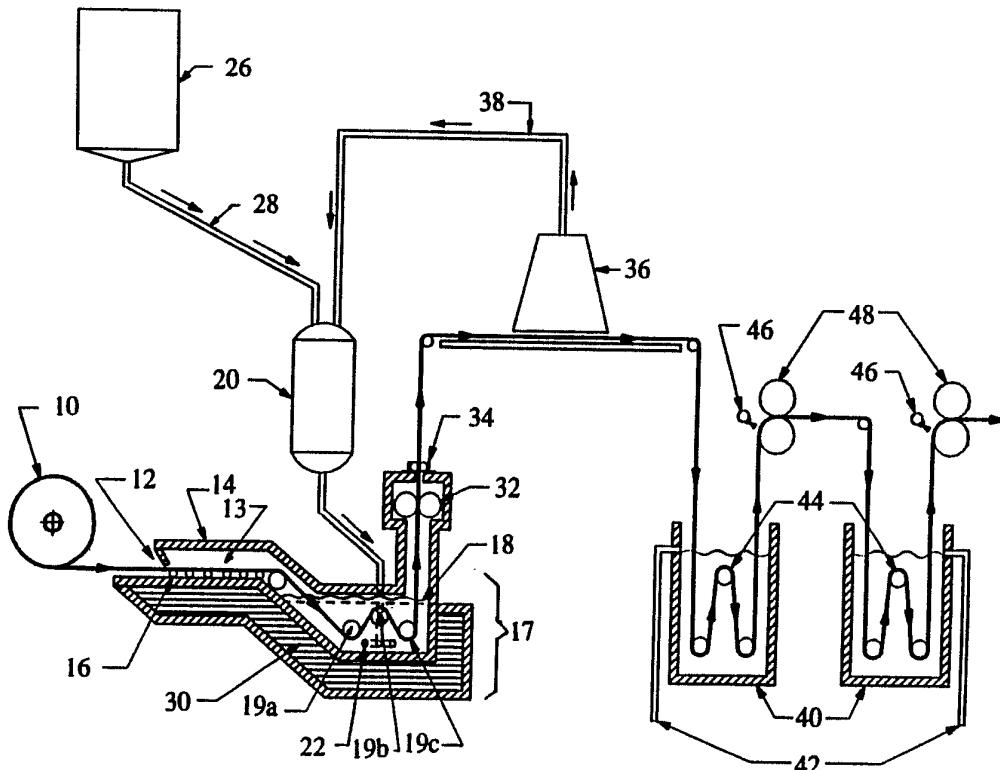




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(71)(72) Applicant and Inventor: FULLER, Benjamin, Franklin [US/US]; 9729 Mountainair Drive, Ooltewah, TN 37365 (US).			Published <i>With international search report.</i>
(74) Agent: COLTON, Laurence, P.; Hurt, Richardson, Garner, Todd & Cadenhead, Suite 1400, 999 Peachtree Street, N.E., Atlanta, GA 30309-3999 (US).			

(54) Title: METHOD AND APPARATUS FOR DYEING CARPET



(57) Abstract

A method and apparatus which utilizes a novel dye solution for dyeing carpet (10) in which the dye solution is heated to a temperature higher than the boiling point of water thus allowing fixation of the dye on the carpet (10) without the need for a steam fixator.

+ DESIGNATIONS OF "SU"

It is not yet known for which States of the former Soviet Union any designation of the Soviet Union has effect.

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METHOD AND APPARATUS FOR DYEING CARPET**BACKGROUND OF THE INVENTION****Field of the Invention**

5 This invention relates to the dyeing of carpets and, more particularly, to a method and apparatus for dyeing carpets which, through the use of a dye bath which has a much higher boiling point than water, does not require the steaming of the carpet to set or fix the dye 10 to the carpet.

Prior Art

Currently known and used methods and apparatuses for dyeing carpet require the steaming of the carpet to set or fix the dye to the carpet after the dye has been 15 applied to the carpet. For example, the typical carpet dyeing method and apparatus involves the application of a dye to the pile surface of the carpet, fixing the dye onto the carpet pile by steaming and then subjecting the carpet to various other finishing procedures prior to drying the 20 carpet.

Once such conventional carpet dyeing process is disclosed in U.S. Patent No. 4,101,270. This patent discloses a method for dyeing carpet which includes the steps of advancing a continuous textile web through a 25 preshrinking station, moistening the textile web, dyeing the textile web using applicator rolls and/or dye applicators, and then fixing the dye onto the textile web by passage through, for example, a chamber containing steam. This basic method generally forms the base for the 30 other prior art carpet dyeing systems and is well known in the art.

Likewise, a second example of a carpet dyeing process including a steam fixator is disclosed in U.S. Patent No. 4,771,497. This patent discloses a process for 35 the continuous treatment of a textile web material

involving the application of a dye to the pile surface of the carpet and then initiating the dye fixation onto the pile surface by steaming. Many of the prior art patents such as the two disclosed above involve such a steam 5 fixation process and are distinguishable from each other by various additional, optional processes added onto this base dyeing technique.

The disadvantages of such prior art carpet dyeing methods and apparatuses which incorporate steam fixation 10 components is the necessity for the steam fixation step. Steam fixation has several disadvantages including the need for a tremendous amount of energy required to heat the steam, dilution of the dye as the steam condenses into water and mixes with the dye, and the cost of the 15 equipment, both in material and time, needed to have a steam fixation step in the carpet dyeing process. A further disadvantage is that a carpet dyeing process including a steam fixation step is uneconomical to operate when dyeing small batches of carpet.

20

SUMMARY OF THE INVENTION

In accord with this invention, a more efficient, less costly carpet dyeing method and apparatus is disclosed. This invention may be used to dye carpets as 25 well as all types of yarns, fibers, woven fabrics, knits and other fabric type materials made from, for example, nylon, polyester, wool, cotton, rayon and acrylics. This invention continuously dyes carpet without steaming by the use of a high temperature dye bath, fed at a specific 30 temperature and flow rate to an applicator, in which the level and the temperature of the dye are controlled.

This invention comprises a novel dye bath applicator which effects the carpet dyeing and fixing step by utilizing a high temperature dye mixture, the 35 temperature of which is higher than the boiling point of

water. The apparatus of this invention also generally comprises a preheater which effects the preheating step, a heated mix tank which effects the heating step of the dye and chemicals, a heat exchanger which effects the step of 5 heating the dye prior to the dye entering the applicator, a vacuum extractor which effects the step of recovering the excess dye and returning it to the heat exchanger, and wash boxes with overflows which effect the step of neutralizing the pH of the carpet and washing the carpet 10 before the carpet enters the drying stage.

This invention eliminates the need for a steam fixator by preheating the dye to a temperature above the boiling point of water and applying it to a preheated textile web. A unique mixture of chemicals allows the dye 15 to be heated above the boiling point of water in this invention such that the dye is fixed onto the carpet pile during the dyeing step, therefore eliminating the need for a steam fixator after the dye application step.

There are numerous advantages to the novel method 20 and apparatus of this invention. Some of these advantages include the elimination of any steam necessary in the dye fixation process, the elimination of the need for gum or thickeners, the elimination of the need for defoamers, and the reduction in the amount of pollutants emanating from 25 the system. Other advantages include the elimination of dye or chemical waste, no increase in chemical and dyestuff content, and the need for less water usage in the system, which water can be recycled. Further advantages of this invention include a more uniform dye application 30 to the carpet from the side to the center to the side of the carpet, better carpet definition, a less expensive dye machine, and the need for less dye space for the dye applicator.

Many conventional dye applicators or machines can 35 be converted inexpensively to the method and apparatus of

the present invention. Additionally, the method and apparatus of the present invention can dye a single strand of carpet yarn or a twelve foot (12') wide piece of carpet or wider, or any carpet size in-between, in a level 5 configuration. It also is economical to dye small dye lots in the present invention as the dye beck time is reduced significantly compared to the prior art. Furthermore, the preheater used in this invention is heated from the heating system used to heat the dye bath 10 applicator, thus saving significantly on heating costs throughout the system.

Accordingly, it is an object of the present invention to provide a carpet dyeing method and apparatus which eliminates the need for a steam fixation apparatus 15 and step.

It is another object of the present invention to provide a carpet dyeing method and apparatus which has lower costs than conventional carpet dyeing methods and apparatuses, including lower power costs, lower machine 20 costs, lower materials costs, and lower operating costs.

It is a further object of the present invention to provide a carpet dyeing method and apparatus which eliminates the need for gums, thickeners, and defoamers.

It is yet another object of the present invention 25 to provide a carpet dyeing method and apparatus which has no dye or chemical wastes and has no increase in chemical and dyestuff content.

It is still another object of the present invention to provide a carpet dyeing method and apparatus 30 which gives a more uniform dye application from side to center to side and which gives better carpet definition.

It is a still further object of the present invention to provide a carpet dyeing method and apparatus which utilizes a less expensive dye machine, takes up less 35 floor space for the dye applicator and uses less water and

recycles the water which it uses.

It is another object of the present invention to provide a carpet dyeing method and apparatus which can dye a single strand of carpet yarn all the way up to a twelve 5 foot (12') wide or wider piece of carpet and which is economical to operate when dyeing small dye lots.

It is yet another object of the present invention to provide a carpet dyeing method and apparatus in which the preheater is heated from the heater unit used to heat 10 the dye bath applicator.

It is also an object of the present invention to provide a unique dye solution which can be heated above the boiling point of water and can be fixed to a textile web without the need for steam fixation.

15 These and other objects of the invention will become apparent to those skilled in the art upon reading the following detailed description of the invention taken in conjunction with the following drawing in which like characters of reference correspond to like parts.

20

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a schematic of the method and apparatus of the present apparatus.

25 **DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT**

A general schematic of the method and apparatus of the present invention showing the various components necessary to carry out this method is shown in Fig. 1. In general, this invention, using a novel dye solution 30 comprising dye, various chemicals as dye assistants and water, utilizes a dye solution which has a much higher boiling point than water. This higher boiling point dye solution is used as a bath to dye carpet. This bath is the main aspect that makes this invention unique from 35 conventional methods of dyeing carpet. The term carpet is

used in this disclosure to cover all fabrics, yarns and textile webs and is not meant to be limited to conventional carpeting as known in the art.

In this invention, carpet is colored by the dye 5 in the higher boiling point bath. The higher boiling point dye bath allows the dye to be fixed to the carpet at that step, thus eliminating the need for a steam fixator. Additionally, the higher boiling point bath is heated in a novel and unique way as compared to the method for heating 10 conventional dye baths. For example, the bath is heated by electric coils or elements or, alternatively, with an enclosed steam system to a temperature greater than the boiling point of water, a temperature which cannot be obtained in conventional systems. The method of heating 15 also provides a more direct heat source.

The presence of a steam fixator causes a dilution of the dye solution. Therefore, the elimination of the steam fixation step also is important to the invention because the dye solution contains a given concentration of 20 dye, chemicals, and water and any dilution of this solution may affect both the coloring of the carpet and the ability of the dye to be heated above the boiling point of water. As the carpet leaves the dye bath, the carpet is squeezed to remove excess dye, which dye is 25 recycled to the dye bath. Then the carpet enters a cold water bath in which the dyeing process is stopped or fixed. Once the dye is fixed, normal variations in color in the carpet from side to center to side do not occur, as is common in continuous dyeing with a steam fixation 30 step. The carpet is then rinsed in one or more wash boxes with overflow.

Referring now to Fig. 1, the dye solution utilized in this invention is stored in a dye vat 26. The dye solution utilized in this invention is a unique 35 mixture of specific dyes, chemicals and water. In

general, dye solutions are formed by dissolving dyes in a portion of the water to be used in the dye bath 18. Dyeing assistants and an acid to control the pH of the dye solution then are dissolved in the balance of the water to 5 be used in the dye bath 18. The dissolved dye and the dyeing assistants and acid then are combined and mixed with a quantity of glycol. The glycol increases the boiling point of the dye solution to a temperature above the boiling point of water. This dye solution is heated 10 to a temperature just below the boiling point of the dye solution, which, due to the mixture of components in the dye solution, is higher than the boiling point of water, and is applied to the carpet 10 in the dye bath applicator unit 17, as described more fully below.

15 Many mixtures of dye, chemicals and water may be made depending upon the dye desired. Useful dyes include, for example, acid dyes, disperse dyes, direct dyes, basic dyes, vats dyes, fiber reactive dyes, and any other dyes that can be applied hot to a substrate. Two examples of 20 representative dye solutions are as follows:

EXAMPLE 1

<u>Component</u>	<u>Percent by Weight</u>	<u>Grams/Liter</u>
25 Dyes (selected acid dyes)	XX.X	X.XX
Benzyl Alcohol (747-Alcohol, DEG Glycol, Anonic and Nonic Surfactant)	0.2	2.00
30 Fulgen SDM (Ethoxylated C12-C15 Primary Alcohol and Coconut Condensate)	0.2	2.00
35 Sulfamic Acid, 15% sol.	1.0	10.00
Water	<u>23.6</u>	<u>316.00</u>
40 Subtotal of Dye	25.0%	330.00
Diethylene Glycol (sp. gr. 1.12) or other types		

of Glycol	75.0	670.00
TOTAL	100.0%	1000.00

5 As described above, the selected acid dyes are first dissolved in a portion of the 316.00 g (or 316 ml) of water great enough to allow for the dissolution of the dyes. The dyeing assistants, such as benzyl alcohol and Fulgen SDM, and an acid to control pH, such as sulfamic acid, are then added to the dye/water mixture. These then 10 are combined and mixed with the diethylene glycol or other glycol, which previously has been mixed with the remainder of the 316.00 g of water, to form the dye solution. The boiling point of this specific dye solution is 15 approximately 228-230°F. This specific dye solution is particularly useful for nylon tufted carpet or other nylon fabrics.

EXAMPLE 2

20 <u>Components</u>	<u>Percent by Weight</u>	<u>Grams/Lite</u>
<u>I</u>		
Dyes	XX.X	X.X
25 Fulpon GP (Potassium Salt of Ethoxylated Phosphate Alcohol)(Phosphated DA-4)	0.2	2.0
30 Water	10.0	130.0
Fulpal ME Anionic Surfactant (P-NP-9)	0.5	5.0
35 Sulfamic Acid, 15% sol.	0.5	5.0
Water	13.8	188.0
Subtotal of Dye	25.0%	330.0
40 Diethylene Glycol or other Glycol	75.0	670.0
TOTAL	100.0%	1000.0

45 As in Example 1, the dye first is dissolved in a

portion of the water great enough to allow for the dissolution of the dye. The water for this specific dye should be hot and a dispersing agent, such as the Fulpon GP, generally is needed to assist in complete 5 dissolution. A leveling agent, such as Fulpal ME, and an acid to control the pH, such as sulfamic acid, is then added to the dye/water mixture. This solution is combined and mixed with a glycol, which previously has been mixed with the remainder of the water, to increase the boiling 10 point of the dye solution. The boiling point of this specific dye solution also is approximately 228-230°F. This specific dye solution is particularly useful for polyester carpet or other fabrics.

Any glycol which allows heat transfer is suitable 15 for the dye solution. The appropriate dyeing assistants are selected so as to complement the fiber being dyed. That is, certain fibers dye better when certain dyeing assistants are used, as is known in the art. Anionic, nonionic, cationic, wetters, levelers, and retarders are 20 all suitable dyeing assistants which are chosen according to the fiber being dyed. Although most any acid is appropriate to add to the dye solution, the most suitable acids include formic, sulfamic, citric, acetic and phosphoric, as well as acid generators.

25 The carpet, indicated generally by carpet roll 10, first enters a preheater 14 before it enters the dye bath applicator unit 17. The preheater 14, which generally is an extension of the dye bath applicator unit 17, generally comprises an entrance door 12, a preheating 30 chamber 13 and transport rollers 16. The entrance door 12 generally is a spring loaded door, or a door with one way hinges, opening toward the interior chamber 13 of the preheater so as to minimize heat loss from the preheating chamber 13 through the door 12 into the atmosphere. The 35 carpet 10 is supported by roller 16 as the carpet 10

travels through the preheater 14.

The purpose of the preheater 14 is to heat the carpet 10 prior to the carpet 10 entering the dye bath applicator unit 17. Preheating of the carpet 10 keeps the 5 dye bath 18 from cooling down and helps open dye sites on the carpet 10 so that the carpet 10 will be ready to take the dye from the dye bath applicators 19. The preheater 14 and preheating chamber 13 are heated using the same heating system 30 that heats the dye bath applicator unit 10 17. The heat system 30 may be any conventional heat system, such as electric coils or enclosed steam. The preheater 14 heats the carpet 10 to any selected temperature up to about 220°F.

The carpet 10 exits the preheater 14 and enters 15 the dye bath applicator unit 17. The dye bath applicator unit 17 generally comprises dye bath 18, dye applicators 19a, 19b, 19c, dye entrance ports 22, squeeze rollers 32, and exit rollers 34.

The dye solution is supplied to the dye bath 20 applicator unit 17 through dye solution entrance ports 22. The dye solution, upon leaving dye vat 26, is introduced through feedline 28 to a heat exchanger 20. The heat exchanger 20, which can be any conventional heat exchanger unit, is used to heat the dye solution to a high 25 temperature, generally to any temperature up to about 240°F, prior to the dye solution entering the dye bath 18 and the dye bath applicators 19a, 19b, 19c. A flow meter (not shown) is located between the heat exchanger 20 and the dye bath application unit 17 so as to regulate the 30 flow of the dye solution to the dye bath 18 so as to keep the level of the dye bath 18 constant.

In the dye bath applicator unit 17, the carpet 10 passes through high temperature dye bath applicators 19a, 19b, 19c which apply the dye solution to the carpet 10. 35 In the dye bath applicator unit 17, the dye is further

heated to between about 160°F and about 240°F. The carpet 10 and the dye bath applicators 19a, 19b, 19c are submerged within the dye bath 18 facilitating in the even application of the dye to the carpet 10. The carpet 10 is 5 threaded under first applicator roller 19a, over second applicator roller 19b, and over third applicator roller 19c to ensure even and thorough dye application. In the dye bath application unit 17, the carpet 10 is submerged in the dye bath 18 as it passes under, over, and under the 10 applicator rollers, 19a, 19b, 19c, respectively.

After the dye solution has been applied to the carpet 10, the carpet 10 leaves the dye bath 18 and passes through squeeze rollers 32 to remove excess dye solution. The squeeze rollers 32 are located above the dye bath 18 15 such that any excess dye solution squeezed from the carpet 10 falls back into the dye bath 18 in a recycle fashion. After having the excess dye solution squeezed from the carpet 10 by the squeeze rollers 32, the dyed carpet exits the dye bath applicator unit 17 through exit rollers 34 20 which serve to remove some excess dye solution and to prevent heat loss from the dye bath applicator unit 17.

The dyed carpet 10, which may still contain excess dye solution from the dye application process, next passes through a vacuum extractor 36. The vacuum 25 extractor 36 is a conventional unit which further removes excess dye solution from the dyed carpet 10 through a vacuum means. Any excess dye solution removed from the carpet 10 by the vacuum extractor 36 is returned to the heat exchanger 20 through recycle line 38. The excess dye 30 solution, therefore, is recycled back to the dye bath applicator unit 17 for dyeing further carpet.

The dyed carpet passes from the vacuum extractor 36 to one or more wash boxes 40. The purpose of wash box 40 is to wash off excess dye solution and chemicals, and 35 to clean the carpet from any other debris which may have

been picked up during the dyeing process. The wash box 40 uses a cold water bath with a neutral pH for the cleaning purpose. A further effect of the cold water bath is to aid in halting the dyeing process and to aid in fixing the 5 dye on the carpet 10 surface.

In operation, the carpet 10 travels between one or more rollers 44 in the wash box 40 to increase the amount of time the carpet is in the cold water bath. Upon leaving the wash box 40, the carpet 10 passes by a spray 10 washer 46 which also acts as the water introduction unit to the wash box 40. After being sprayed with cold water by the spray wash 46, the carpet 10 passes through squeeze rollers 48 to remove excess water. In some applications, it is advantageous to have a plurality of wash boxes 40 15 which generally are identical with each other. Each wash box 40 also is equipped with an overflow 42 to maintain a constant level of water in the wash box 40. After leaving the wash box 40, the carpet 10 is dried in a conventional manner, using conventional carpet drying apparatus.

20 The above process when applied with the appropriate apparatus will dye nylon, polyester, cotton, wool and other fibers utilizing acid, disperse, direct and basic class dyestuffs. The above process when utilized with the appropriate apparatus also accomplishes currently 25 acceptable fastness and crocking performance levels with no steamer unit or other steam requirement for satisfactory color setting. Furthermore, the process of this invention when utilized with the appropriate apparatus achieves near 100% exhaustion of the dye 30 solution and reduces affluent waste in the dye process by approximately 75% and is applicable to certain existing equipment upon modification of that equipment. When the carpet 10 comes out of the dye bath 18, the color shade is fully developed and will not continue to build in color 35 department. Further, the water used in the wash box 40

can be recycled with simple plumbing additions (not shown).

The apparatus of the present invention can be retrofitted to most existing carpet dyeing equipment of the continuous range variety. The primary change would be 5 to install the dye bath applicator 17 in line with the existing equipment. The existing steamer can be removed from the existing equipment as it is no longer needed, and the dye bath applicator 17 may be installed in its place. Alternatively, the dye bath applicator 17 may be placed 10 immediately before the existing steamer with the carpet 10 first traveling through the dye bath applicator 17, then through the existing steamer, then to the carpet washing system. If this alternative is utilized, the existing steamer need not be turned on as it is unnecessary. 15 Likewise, the dye bath applicator 17 may be placed immediately after the existing steamer with similar results.

This invention can be applied to all continuous dye ranges for carpet dyeing and to all forms of yarn 20 dyeing such as, for example, warp, skein and knit-deknit space dyeing. This invention produces superior side to side color matching on continuous dye ranges and produces improved tuft definition and hand in saxony and velvet cut pile constructions. Furthermore, this invention has no 25 practical limitation on speed other than the equipment speed limitations. Carpet dyed by the present process and apparatus displays superior color characteristics when compared to carpets dyed by conventional dye becks and continuous ranges.

30 It will be obvious to those skilled in the art that many variations may be made in the embodiment chosen for the purpose of illustrating the best mode of this invention without departing from the scope thereof as defined by the appended claims.

I Claim

1. An apparatus for dyeing fabric materials comprising a dye bath means and a heating means which heats a dye to a temperature higher than the boiling point 5 of water, that being 212°F at standard temperature and pressure.
2. The dyeing apparatus as described in Claim 1, further comprising a preheating means to preheat the fabric material prior to the fabric material being 10 introduced to the dye bath means.
3. The dyeing apparatus as described in Claim 1, further comprising a dye mixing means, said mixing means comprising means for heating the dye prior to the dye being introduced to the dye bath means and means for 15 introducing the dye to the dye bath means.
4. The dyeing apparatus as described in Claim 1, further comprising dyeing means for applying a dye to the fabric materials.
5. The dyeing apparatus as described in Claim 4, 20 further comprising removal means for removing excess dye from the fabric materials, said removal means being located downline from said dyeing means.
6. The dyeing apparatus as described in Claim 5, further comprising vacuum means for recovering excess dye 25 from the fabric materials, said vacuum means being located downline from said removal means.
7. The dyeing apparatus as described in Claim 6, further comprising recycle means for recycling said recovered excess dye to said mixing means.
- 30 8. The dyeing apparatus as described in Claim 6, further comprising washing means for washing the fabric materials, said washing means being located downline from said vacuum means.
9. A method for dyeing fabric materials 35 comprising the steps of:

- a. providing a dye solution;
- b. providing a fabric material;
- c. heating said dye solution to a temperature above the boiling point of water, that being 5 212°F at standard temperature and pressure; and
- d. applying said heated dye solution to said fabric material.

10. The dyeing method as described in Claim 9, further comprising the step of preheating said fabric 10 material prior to step d.

11. The dyeing method as described in Claim 10, wherein said fabric material is heated to a temperature above the boiling point of water, that being 212°F at standard temperature and pressure.

15 12. The dyeing method as described in Claim 9, further comprising the step of preheating said dye solution prior to step c.

13. The dyeing method as described in Claim 12, wherein said dye solution is heated to a temperature above 20 the boiling point of water, that being 212°F at standard temperature and pressure.

14. The dyeing method as described in Claim 9, further comprising the step of removing excess dye solution from said fabric material subsequent to step d.

25 15. The dyeing method as described in Claim 14, further comprising the step of recycling said excess dye solution.

16. The dyeing method as described in Claim 9, further comprising the step of washing said fabric 30 material subsequent to step d.

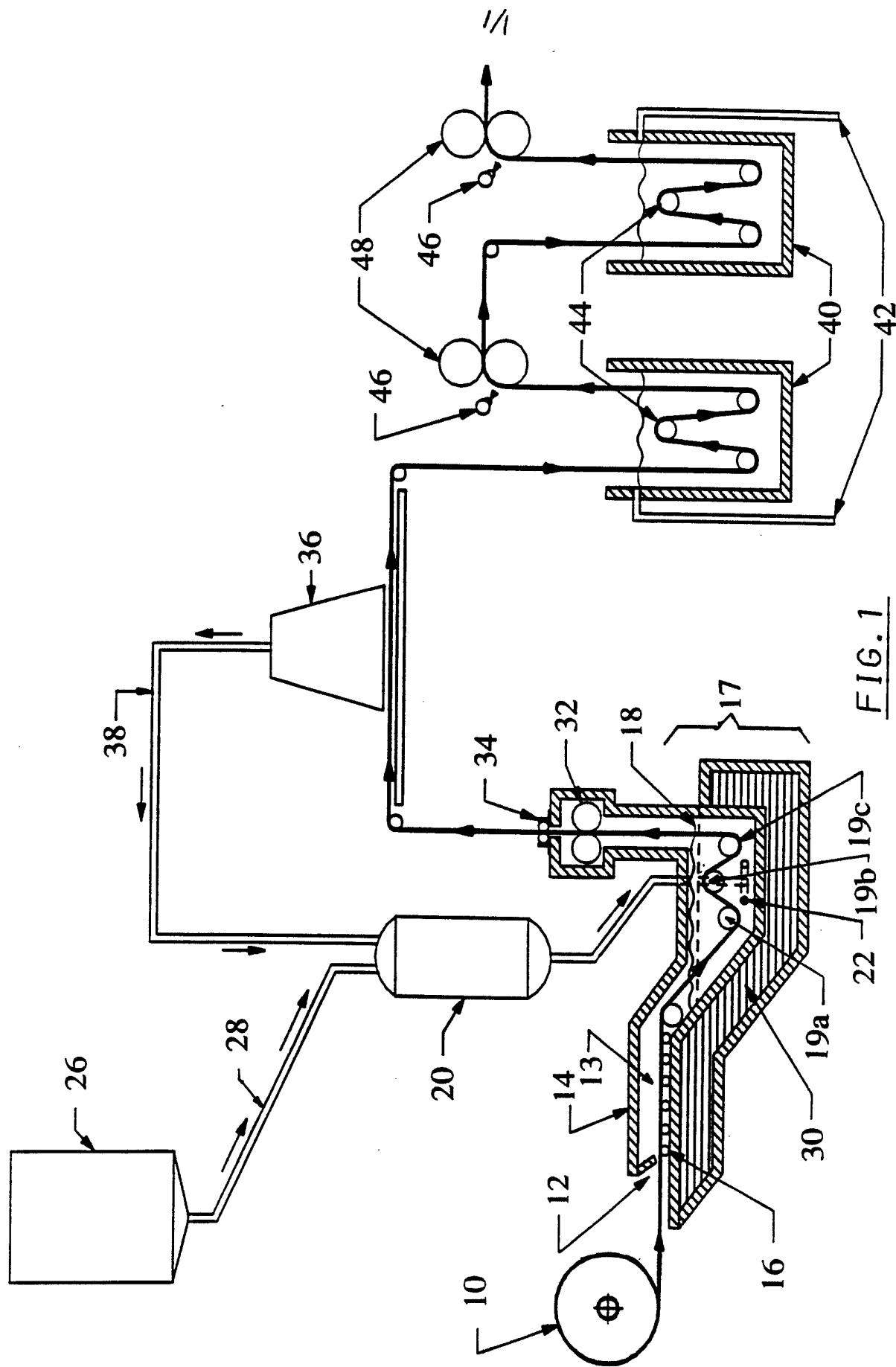
17. The dyeing method as described in Claim 9, further comprising the step of neutralizing the pH of said dye solution and said fabric material subsequent to step d.

18. The dyeing method as described in Claim 9, 35 further comprising the step of drying said fabric

materials subsequent to step d.

19. A dye solution comprising dye, dyeing assistants, acid and water.

20. A dye solution as described in Claim 19, 5 wherein said dye is selected from the group consisting of acid dyes; said dyeing assistants are selected from the group consisting of alcohols, glycols, anionic surfactants, ionic surfactants, and coconut condensate; and said acid being sulfamic acid.



SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US 91/05469

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *

According to International Patent Classification 1 National Classification and IPC
IPC (5) : D06B 3/10

U.S.CL: 8/151, 158, 929, 930, 932; 68/9, 15, 19.1, 20

II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System	Classification Symbols
	8/151, 158, 929, 930, 932, 934;
U.S.	68/5E, 9, 15, 19.1, 20

Documentation Searched other than Minimum Documentation
 to the Extent that such Documents are Included in the Fields Searched 8

III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

Category *	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No. 13
X	US,A, 2,387,200, Walter, 16 October 1945 (see the entire document)	1,2,4,5,9,10, 14-17
Y		6-8
X	US,A, 3,986,831, Vonder Eltz ET AL, 19 October 1976 (see the entire document)	1-5
X	US,A, 3,418,065, Blount, Jr., 24 December 1968 (see the entire document)	9-13
X	US,A, 4,082,502, Vonder Eltz ET AL, 4 April 1976 (See the entire document)	9-14 and 16-18
Y	US,A, 4,447,924, Bolton ET AL, 15 May 1984 (see the entire document)	6-8
X	US,A, 4,058,517, Bermes, 15 November 1977 (see the entire document)	19-20
A	US,A 3,707,351, Mecco, 26 December 1972	
A	US,A, 3,922,738, Holm, 2, December 1975	

* Special categories of cited documents: 10

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search

29 August 1991

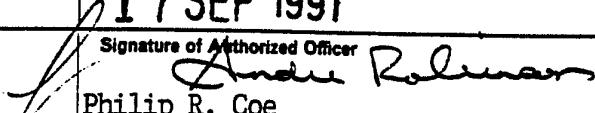
International Searching Authority

ISA/US

Date of Mailing of this International Search Report

17 SEP 1991

Signature of Authorized Officer


 Philip R. Coe

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A	US,A, 4,655,786, Nauratil ET AL, 7 April 1987
A	GB,A, 242,790, Dean, 19 November 1925
A	GB,A, 2,063,943, Sando ET AL, 10 June 1981
A	GB,A, 2,125,449, Wesseley, 7 March 1984

V. OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE¹

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. Claim numbers because they relate to subject matter¹³ not required to be searched by this Authority, namely:

2. Claim numbers because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out¹³, specifically:

3. Claim numbers because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING²

This International Searching Authority found multiple inventions in this international application as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

The additional search fees were accompanied by applicant's protest.
 No protest accompanied the payment of additional search fees.