United States Patent

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[54] **PROCESS AND APPARATUS FOR THE FIXING OF DYES**
7 Claims, 4 Drawing Figs.

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[51] **Int. Cl.** **D06p 3/00,** D06p 5/00
[50] **Field of Search** 8/2, 64, 73, 149.3, 176; 68/5

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ABSTRACT: A dye-fixing process which follows the treatment of lengths of materials containing synthetic fibers, such as polyester and polyamide fibers, with dyes, including dispersion dyes, said process comprising the steps of heating a dried dye-carrying length of material with pure steam or a steam-air mixture containing over 75 percent steam by volume by condensation of steam to a saturation temperature of substantially 90° to 100° C., then heating said length of material with media having heat-transmission values of at least 50 k. cal./m^2/°C. /h. by a heating curve which is a continuously increasing temperature of the fabric and which approaches asymptotically and then reaches a fixing and treating temperature of at least 150° C., the heat flux being determined by measuring temperatures, duration, length surfaces as well as average flow amounts and speeds, and then subjecting the material to a continuous thermostorage treatment at said treating temperature for a time period ranging between 10 and 100 seconds.

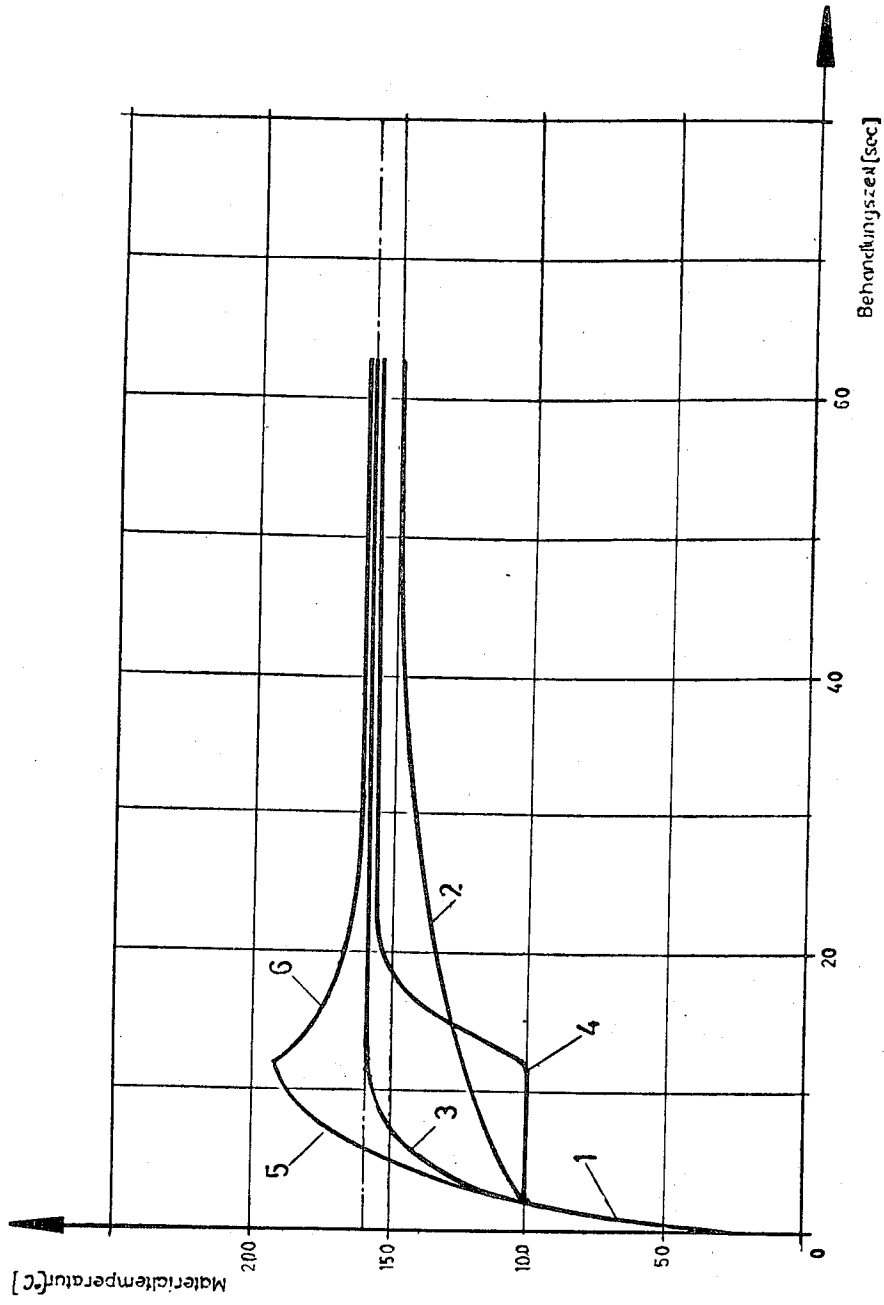

Fig. 1

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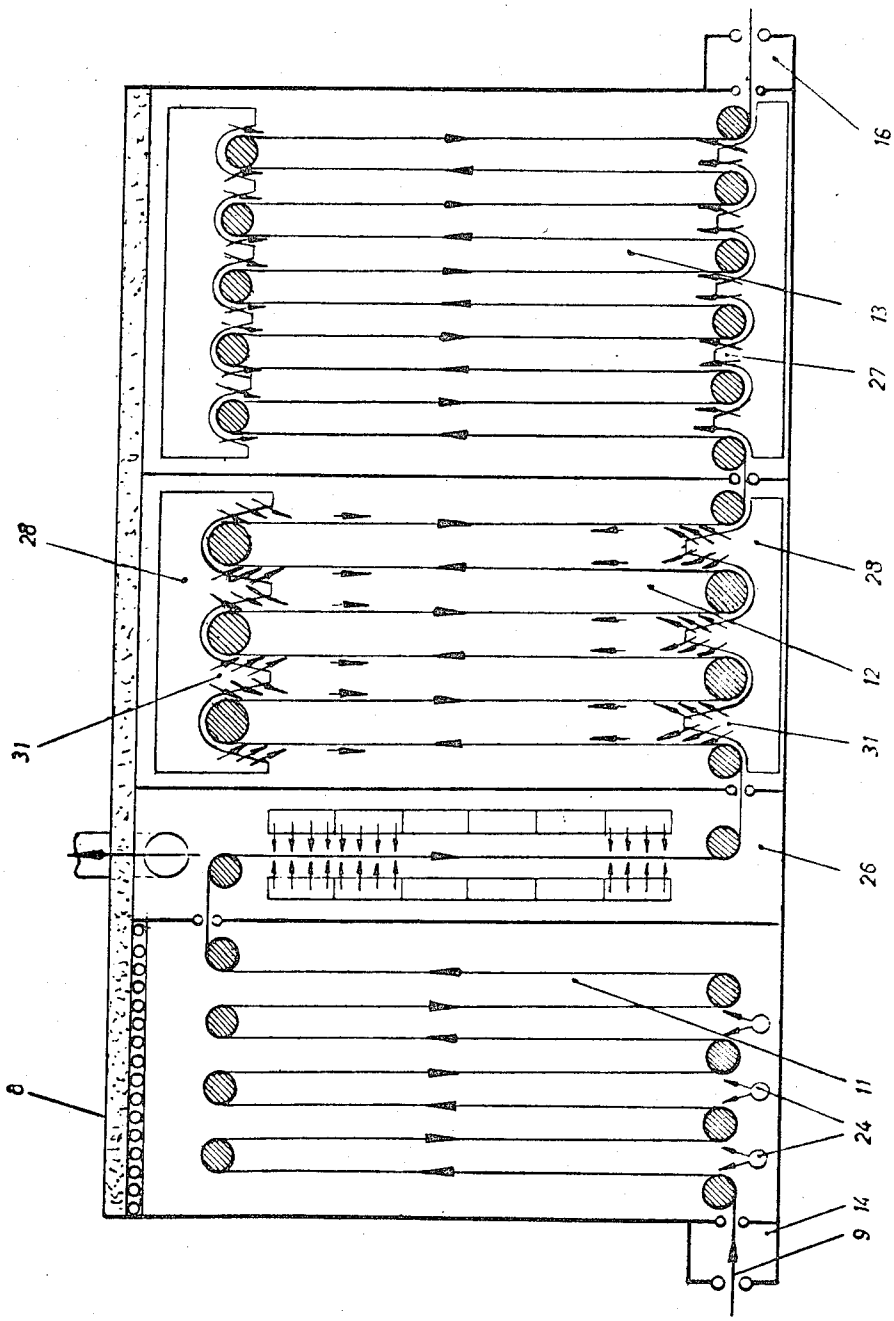
Fig 2



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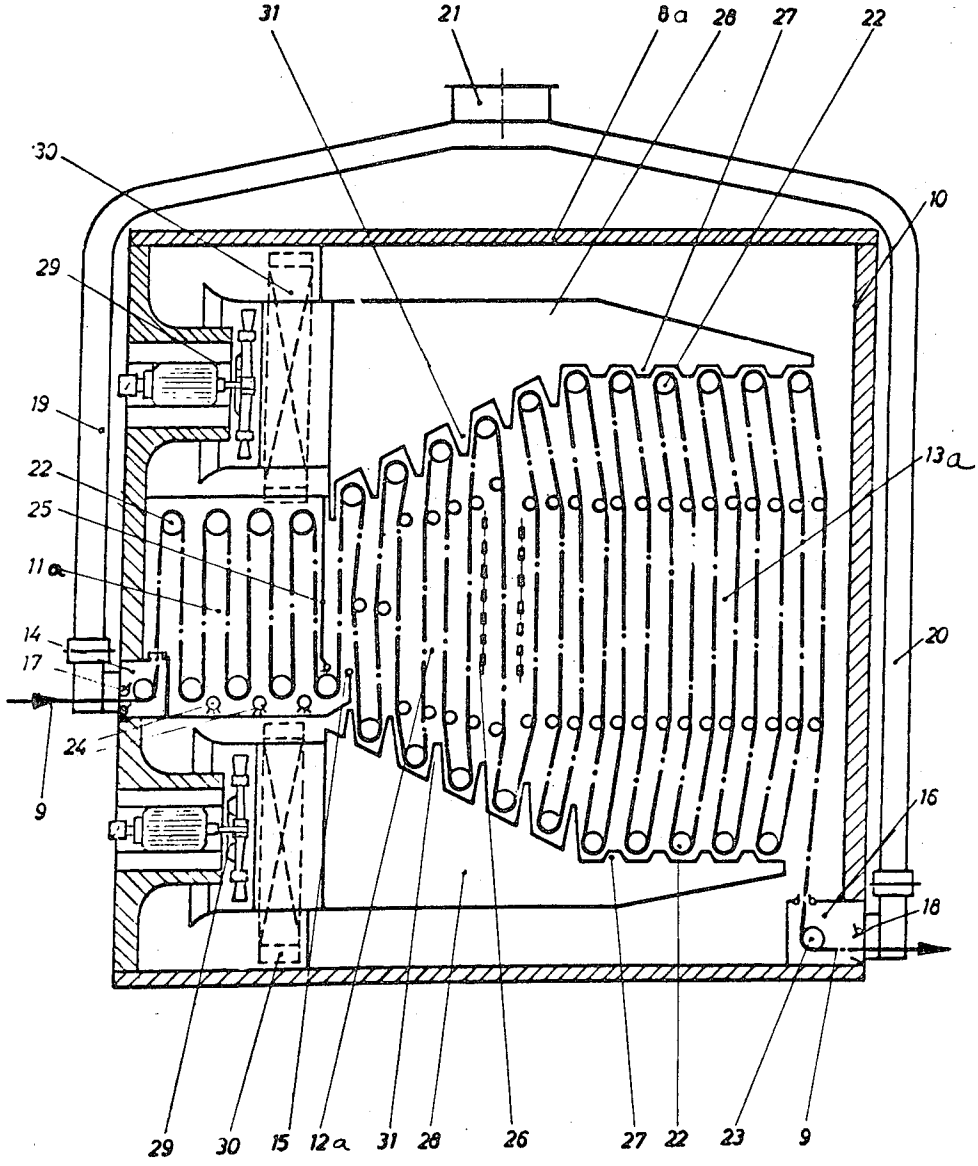

Fig. 3

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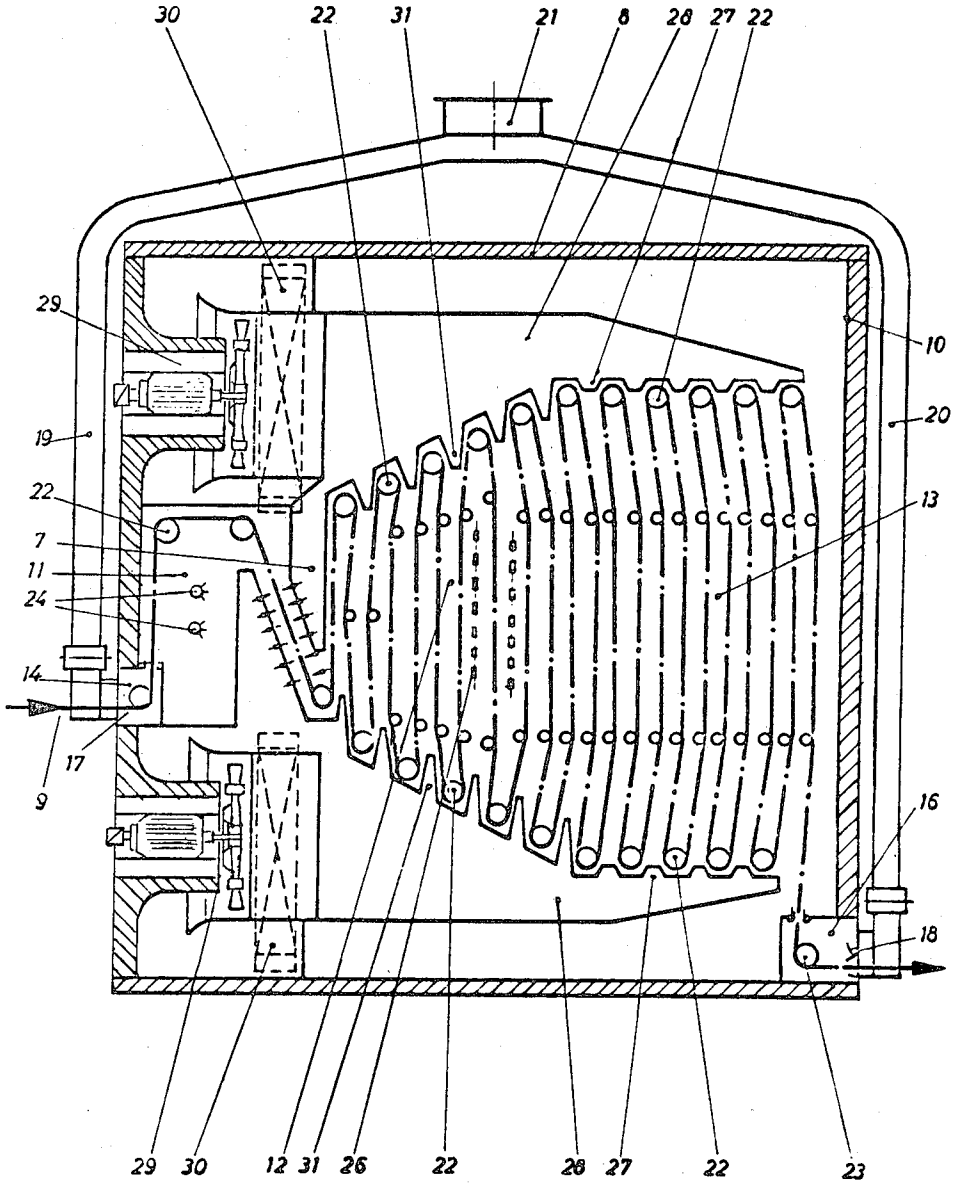

Fig. 4

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PROCESS AND APPARATUS FOR THE FIXING OF DYES

This invention relates to a process for fixing dyestuffs in textile-printing and dyeing, and to apparatus for carrying out the process.

Processes for fixing dyestuffs at present in use such as the Thermosol process, have numerous disadvantages among which are that sublimation of the dyestuff may occur and stenter frames are required to control lateral shrinkage of the web or that the process is not continuous.

According to the present invention there is provided a process for continuous fixing of dyestuffs on webs of material at normal atmospheric pressure, in which a web to be treated, after impregnation or printing, is dried; heated to predetermined dye-fixing temperature; and then subjected, at this temperature, to a duration dye-fixing treatment, and in which the drying, heating and at least part of the dye-fixing treatment is carried out in a medium comprising pure superheated steam or a steam-air mixture having a steam content of over 80 percent.

Further, according to the present invention there is provided apparatus for carrying out the process aforesaid including a preliminary condensation-heating chamber, a heating chamber for heating a web of material to a predetermined treatment temperature, and a duration dye-fixing heat treatment chamber, sequentially arranged in a common housing.

In one example of the process according to the invention a polyester web having a dispersion dyestuff print undergoes a preliminary, steam-condensation heating to around 100° C. in an atmosphere of pure steam, or a steam air mixture with a steam content of at least 80 percent. The web is then heated to a duration treatment temperature of 155° C. and then undergoes duration dye-fixing in an atmosphere of pure steam for a treatment time of 45 seconds. The heating to the treatment temperature is carried out in an atmosphere of pure steam, or a steam-air mixture with a steam content of at least 80 percent and has a heat transfer of 50 k. cal./m.²/°C. with a heat transfer characteristic in which the desired duration dye-fixing temperature of 155° C. is approached asymptotically. This process provides excellent and consistently reproducible dye-fixing.

It has been found that in the process according to the invention certain of the disadvantages present in previously known process, such as radiation effects of cold wall parts or heat loss through web guides, no longer necessarily have a detrimental effect on the process. Moreover, only a heat transfer having an asymptotic characteristic results in reproducible and uniform dye-fixing over the width of the web being treated and over the lengths of the individual parts of the web, especially when the web comprises parts of different materials.

Particularly consistent results may be obtained by intensively swirling the steam medium during the duration dye-fixing treatment and by repeatedly directing the medium, either perpendicularly or obliquely tangentially, uniformly on to the material undergoing treatment.

In a further example of the process according to the invention similar results to those obtained in the previous example are achieved using heated cylinder surfaces contained in the heating chambers, and which are heated to the desired treatment temperature. In this case it was found that the treated material did not have any of the detrimental surface effects similar to those produced by the Thermosol contact process.

Relatively more brilliant color effects may be obtained if a predetermined amount of radiation heating is applied to the material during the heating to the desired treatment temperature.

An extensive range of tolerances arise from the different effects produced by variation of preliminary heating temperature, duration treatment temperature, duration treatment times and whether or not the dyestuff being fixed is a print on the material or a complete dyeing of the material.

For prints having relatively heavy thickener (pastes), lower duration treatment temperatures in the range of 145°–160° C. and duration treatment times in the range of 30—60 seconds

are acceptable and produce excellent results. Moreover, a particularly advantageous result is obtained when the process includes a duration period of several seconds during the condensation heating to allow condensation damping to take effect before the material is heated to the desired duration treatment temperature.

With certain combinations of dyestuff and types of material, a "boost" heating after the preliminary condensation heating and to a temperature in excess of the treatment temperature, followed by asymptotic colling to the desired treatment temperature, gives excellent dye-fixing results.

The process according tot the invention is also applicable to simultaneous dye-fixing of dyestuffs of various types applied to materials comprising, on the one hand natural and regenerated fibers, or on the other hand synthetic fibers. Thus, the process is of major importance in printing and dyeing of materials comprising mixtures of fibers. In this case relatively low treatment times are chosen from the ranges available.

In some instances it is possible to carry out the final part of the duration dye-fixing treatment at constant temperature in an atmosphere comprising a steam-air mixture having a relatively low steam content, and sometimes comprising pure air.

The invention is explained in more detail, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a graph illustrating various temperature/time characteristic curves;

FIG. 2 is a diagrammatic sectional view of apparatus for carrying out the process according to the present invention;

FIG. 3 is a diagrammatic sectional view of a high temperature continuous steamer; and

FIG. 4 is a view corresponding to FIG. 3 and showing a modification.

The temperature/time or heat-transfer characteristic curves shown in FIG. 1, indicate the temperature of a material being treated at any given time. Curve 1 shows the rise in temperature of the material during the preliminary, condensation-heating to 90°–100° C. with relatively high heat-transfer. Curve 2 refers to a slight convective heating, as would result if superheated pure steam without any intense motion of the steam were used to heat the material to the desired treatment temperature, and which often never quite reaches the desired temperature because of various losses. Curve 3 shows the characteristic of the heat-transfer to a material undergoing the process according to the invention, showing the relatively high heat-transfer and having a heat-transfer characteristic with asymptotic approximation to the desired duration treatment temperature. Curve 4 shows the heat transfer characteristic in a modified process according to the invention and in which a relatively short duration is included after the preliminary condensation-heating to 90°–100° C. Curves 5 and 6 show the heat transfer characteristics of a further modified process according to the invention, which includes "boost" heating to a temperature in excess of the desired treatment temperature, followed by asymptotic coolings to the desired treatment temperature by means of strong convective cooling. 160° C. is given as an optimum desired duration treatment temperature in the given examples. The extension of the duration of the individual phases of the process is not shown exactly to scale, in order to make the graph more clearly understandable. The relatively short duration incorporated after the preliminary condensation-heating is in the range of 5 to 10 seconds, the preliminary condensation-heating lasts for 1 to 2 seconds, the heating above the desired treatment temperature lasts for 2 to 5 seconds and the duration treatment time is in the range of 10 to 100 seconds.

The sequence of operation of the process according to the invention is as follows. A web of material 9 is first led into a housing 10 including a chamber 11 in which chamber it undergoes preliminary condensation-heating to approximately the saturation temperature of the steam (9° to 100° C.) in a medium having a steam content in the range 75 to 100 percent and having a temperature in the range of 100°–120° C. Spray-tubes 24 are provided in the chamber 11 for the introduction

of the medium. After the preliminary heating the web passes to a zone **26**, (FIG. **2**) where the material **9** is subjected to radiation heating to approximately ⅔ of the desired treatment temperature.

In the modified processes shown in FIGS. **3** and **4**, the radiation-heating may alternatively be situated in the chamber **12** at the beginning of the last third of the heating to the desired treatment temperature.

The web **9** now passes to a heating chamber **12** which is shielded from the chamber **11** by a partition wall **25**, which is isolated by seals **15**, and in which the web **9** is brought to the desired treatment temperature by convective heat-transfer having the desired asymptotic heat-transfer characteristic. In the examples shown the heating medium is supplied through sieve jets **31** provided in a duct **28**. The feeding of the medium to the jets **31** is effected by a blower **29** which transports the steam of medium through heat exchangers **30**, in a closed circuit. From the chamber **12** the web **9** passes into a duration dye-fixing treatment chamber **13** to which the treatment medium is supplied through jets **27**. The latter may be provided in the duct **28** (FIGS. **3–4**) or may be supplied by a branch **28A** thereof. As it is unnecessary to have as intensive heating of the material in the duration chamber **13** as in the heating chamber **12**, simpler jets **27**, than the jets **31**, can be used in the duration chamber **13**. In the chamber **13** the desired treatment temperature need only be maintained. After passing through the chamber **13**, the web **9** is led out of the housing **10**, over an exit roller **23**. The housing **10** as can be seen from the drawings, contains all three chambers **11**, **12**, **13** and is provided with insulation **8** on its outer walls.

At the entry of the web **9** into the housing **10**, there is provided a lock **14** and at the exit therefrom a similar lock **16**. The locks **14**, **16** are provided with seals **17**, **18** which prevent cold air from entering the housing **10**, and steam from escaping into surrounding space. In order to prevent any escape of steam into the surrounding area, suction tubes **19** and **20** are provided in front of and behind the entry and exit for the strip, which open into a common suction duct **21**.

When a web **9** printed on one side is to be treated, it is not possible to pass the web over guide rollers which contact both sides of the web in the condensation-heating chamber **11**, as spotting of the colors on the rollers would occur. For this reason the chamber **11** may be made in such a way (see FIG. **4**) that the web **9** only lies on the rollers **22** on one side and before placing the web on its other side on the rollers is necessary, the web is led through a jet-drier **7**, in which drying of the dyestuff occurs to such an extent that spotting is avoided.

In other respects the construction and operation of the devices shown in FIGS. **3** and **4** are the same as those of the apparatus of FIG. **2**.

What is claimed is:

1. A dye-fixing process which follows the treatment of lengths of materials containing synthetic fibers, such as polyester and polyamide fibers, with dyes, including dispersion dyes, said process comprising the steps of heating a dried dye-carrying length of material with pure steam or a steam-air mixture containing over 75 percent steam by volume by condensation of steam to a saturation temperature of substantially 90° to 100° C., then heating said length of material with media having heat transmission values of at least 50 k. cal./m²/C.°/h. by a heating curve which is a continuously increasing temperature of the fabric and which approaches asymptotically and then reaches a fixing and treating temperature of at least 150° c., the heat flux being determined by measuring temperatures, duration, length surfaces as well as average flow amounts and speeds, and then subjecting the material to a continuous thermostorage treatment at said treating temperature for a time period ranging between 10 and 100 seconds.

2. The process in accordance with claim **1**, wherein the length of material is heated to the treating temperature by convective heating with highly increased flow speeds of said medium adjacent the surfaces of the material.

3. The process in accordance with claim **1**, wherein the thermostorage treatment takes place in pure steam.

4. The process in accordance with claim **1**, wherein said treating temperature is less than the fiber fixing temperature of the fibers of said material.

5. The process in accordance with claim **1**, wherein said material carries imprinted dyes, and wherein said condensation-heating continues for 1 to 2 seconds, followed by said heating to the treating temperature which is higher than the saturation temperature of steam.

6. The process in accordance with claim **1**, wherein said condensation-heating is followed by a short radiation treatment.

7. The process in accordance with claim **6**, wherein said radiation treatment continues for 2 to 5 seconds and heats said material to a temperature which is at least equal to said treating temperature, and immediately following said treatment the temperature is dropped to below the fiber-fixing temperature.

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