Dec. 24, 1968 C. BLOUNT, JR 3,418,065

METHOD FOR HIGH TEMPERATURE DYEING

Original Filed Jan. 10, 1961 3 Sheets-Sheet 1

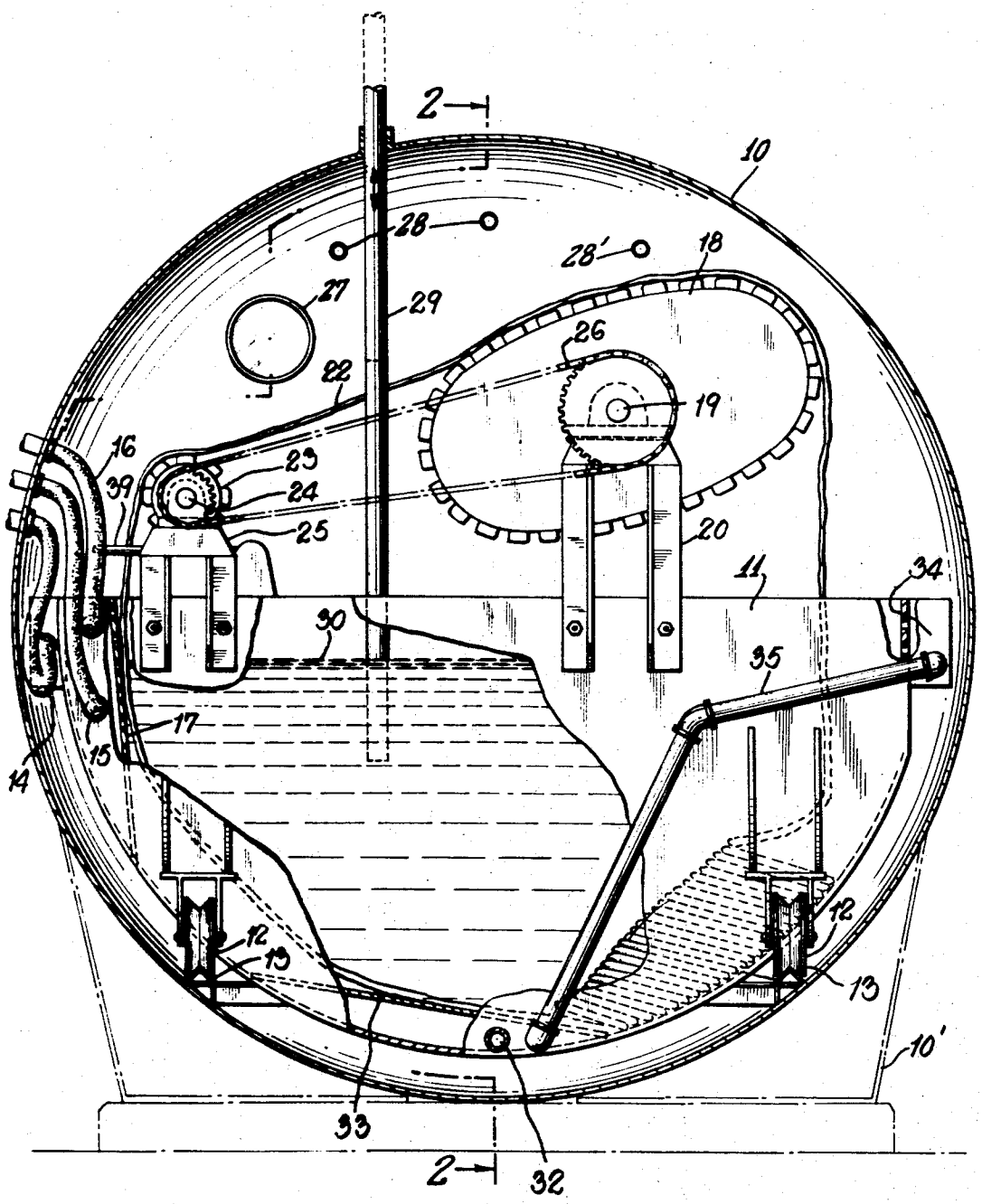


FIG. 1

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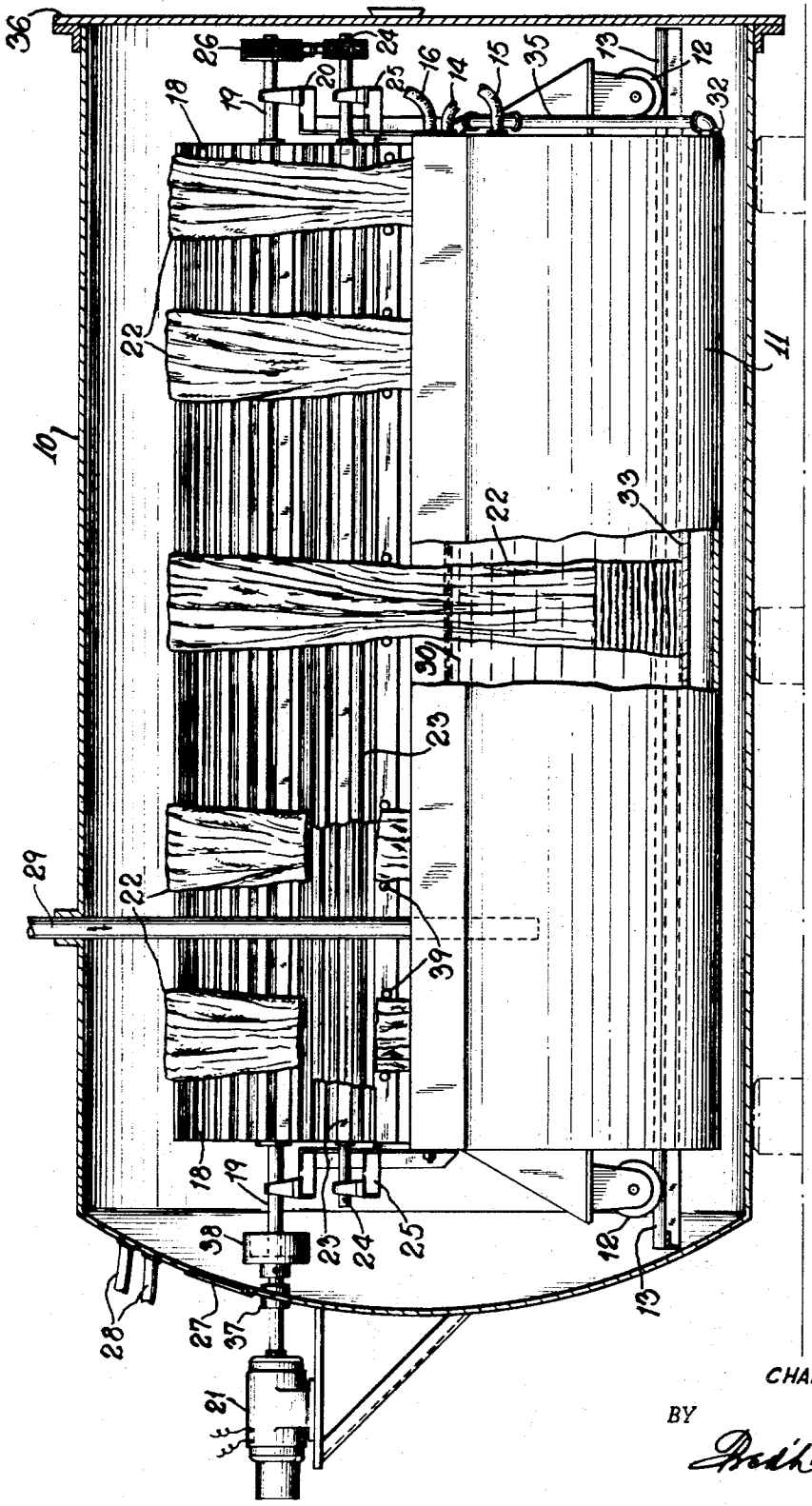


FIG. 2

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FIG. 4.

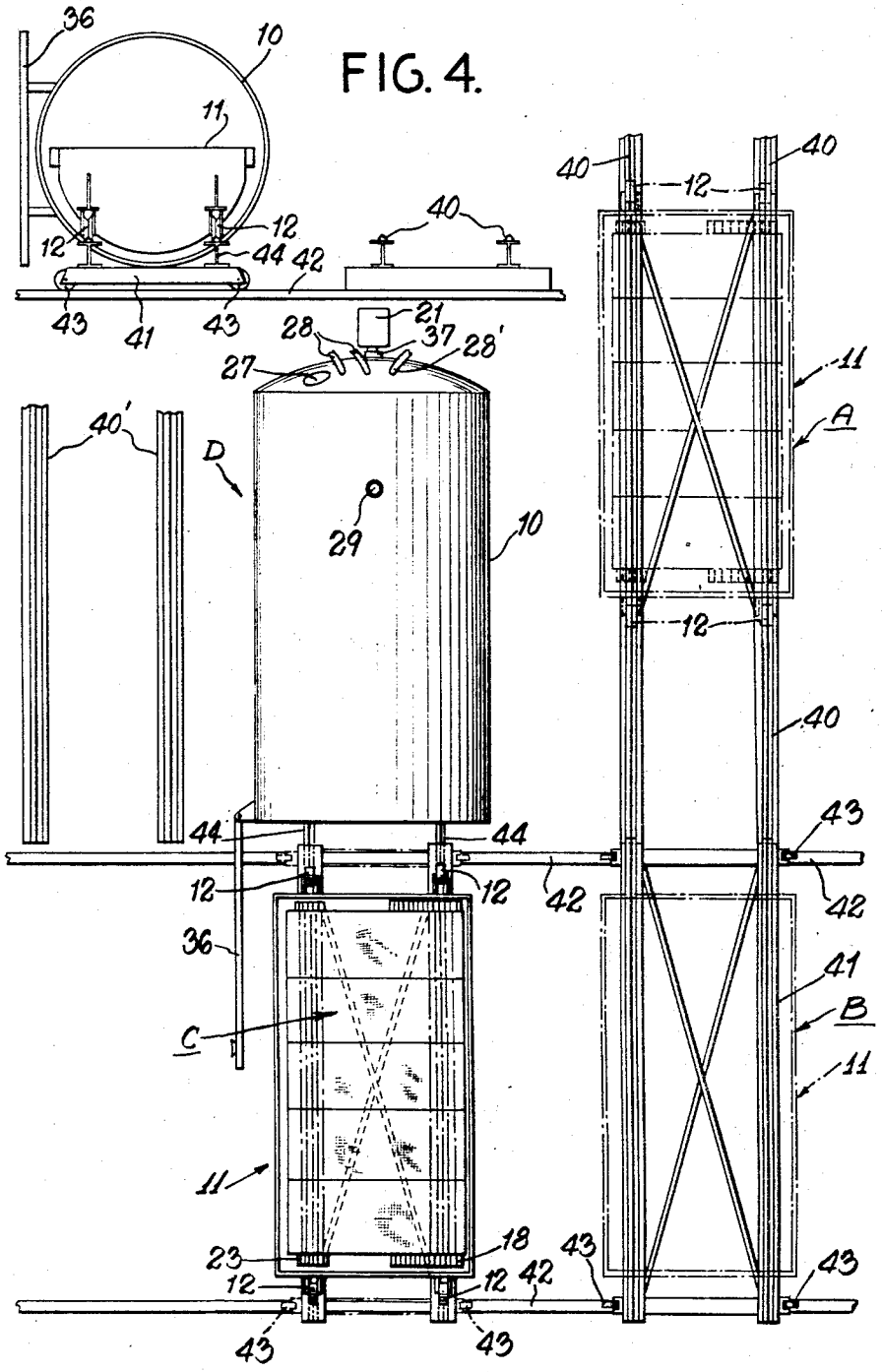


FIG. 3

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METHOD FOR HIGH TEMPERATURE DYEING

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Division of application Ser. No. 81,780, Jan. 10, 1961. Continuation of application Ser. No. 295,592, July 9, 1963, both now abandoned. This application Oct. 4, 1965, Ser. No. 498,194

2 Claims. (Cl. 8—55)

This is a continuation of my co-pending patent application, Ser. No. 295,592, filed July 9, 1963 now abandoned, and a division of my patent application, Ser. No. 81,780, filed Jan. 10, 1961, now abandoned.

The invention relates to a method for effecting the dyeing of synthetic fibers and synthetic sheets or film, particularly as embodied in a fabric which is composed, for example, either in whole or in part of polyester fibers, e.g. Dacron, Kodel, Vycron, etc.; or in a sheet or film composed, for example, of such synthetic as Mylar sheeting.

Heretofore, dyeing of synthetics of the aforesaid nature at atmospheric pressure and temperatures below 212° F. required a dyeing cycle of the order of 25 hours—6 hours of which being consumed in chemical treatment for the removal of sizing waxes and oils added during the weaving process of fibers into fabric. This dyeing period however can be reduced appreciably—to the extent of 35% or more—by the addition of chemical carriers to the dye bath. Such carriers appear to carry dyestuff from an aqueous dispersion thereof to the fiber and thus disturb the equilibrium between dye-bath and fiber in favor of the dyestuff absorption by the synthetic fiber. Moreover, even with the use of such carriers—which are costly—the rate of dyeing porceeds extremely slowly, the dyeing cycle being of the order of 8 to 16 hours per dye lot. In addition the use of such carriers presented numerous problems in the handling and disposing of the same. Such carriers are generally obnoxious to work with in that they have a disagreeable odor which necessitates special needs for venting any building where they are being used. Also such carriers are toxic as well as inflammable. Further, expensive treatment thereof is required in order to dispose of the same as waste. Such carriers after use cannot be simply dumped into the natural disposal channels without treatment as they would render the normal disposal channels, e.g. rivers, unfit.

It is known that, at temperatures substantially above 212° F., the dyeing cycle can be considerably shortened and that the operation may be conducted without the addition of chemical carriers. Therefore, in the art of dyeing synthetics, it has long been recognized that a process for conducting the dyeing at relatively high temperatures is desirable; one of the advantages among others, being that the synthetics at such high temperatures have a greater affinity for the dye.

Heretofore, numerous attempts have been made to develop such a high temperature process and suitable apparatus for carrying out the same. The most successful known method to date involves winding the fabric on itself about a perforated cylinder under tension and subjecting the tensioned material to the dye under elevated temperature and pressure conditions while flowing the dye liquor through the fabric. The practice in such operation has been to alternate the flow of the dye liquor through the fabric, i.e. to flow said liquor in a tank through fabric from inside to outside and then to reverse the flow pattern. This method has met with only limited

success and for several reasons. This is because the cloth must remain in an unrelaxed state throughout the dyeing process. Thus, extra caution must be observed to insure that the fabric wound about the cylinder is not creased, as otherwise the creases will become permanently fixed during the dyeing operation. Furthermore, the tension of the wind is critical, in that a too tight wind results in overload of the power source and conversely a too loose wind results in damage to material. Also, there is a tendency for the fabric to become unevenly shaded along its length and width; the result of a condition known in the trade as non-leveling of the dye. This condition is due partly to the filtering action of the sevral layers of cloth—thus only loosely woven cloth may be dyed by this method and closely woven cloth cannot be so dyed—and partly due to uneven penetration of the dye in and around the fibers caused by the pressure characteristics of fluid flow through layers of open width fabric. Finally, a phenomenon referred to as "moiré" occasionally occurs during the dyeing operation, with the result that the entire dyed fabric must be discarded or re-dyed. Also the loading of such machines presents complication and is time consuming. In addition the size of the lot is limited by the foregoing factors, and by the weight and weave of the fabric.

In another known type of machine the fabric is wrapped in one or more thicknesses in full open width around a star reel supporting rods, which support the fabric. Accordingly the star reel is rotated moving the fabric slowly through the dye liquor. In this form, also, the fabric is required to be stretched in open width. The disadvantages of dyeing in this manner are similar to those above noted. Also stick-marks are produced in fabric.

Prior to this invention it has also been believed that an apparatus for dyeing synthetic fabric at high temperature and under pressure in relaxed rope strands would be prohibitive, not only in cost, but also in practical application. It was generally believed by those skilled in the art that fabric dyed under these conditions in relaxed rope strands would show creases and breaks which would be impossible to remove in subsequent processing operations.

Therefore, it is an object of this invention to provide a method of high temperature dyeing of synthetic fabric in which the fabric is passed through its dye bath in a relaxed, rope strand fashion.

It is another object to provide a method for high temperature dyeing of synthetic fabrics in which the time required for accomplishing the same is greatly reduced over the time required with known processes.

It is still another object to provide an improved method of dyeing synthetic fabrics in which the resort to carriers is eliminated.

It is still another object to provide an improved method of high temperature dyeing of fabric which comprises only in part a synthetic fiber.

Also in accordance with the novel method of dyeing herein, in the case of fabrics—which are constituted in whole or in part of synthetic fibers, as well as sheets and films of synthetic material, such as Dacron, Kodel, Vycron, Mylar, etc.—it becomes possible to eliminate a pre-dyeing step termed "boil-off," which operation constitutes the removal of oils and waxes as well as other deleterious substances added during, and to facilitate, the weaving process except in the case of those fabrics which require further treatment after dyeing to give waterproof characteristics thereto.

I have found in high temperature dyeing, in accordance with my invention, that with the addition of a non-ionic detergent to the dye bath, and while under high temperature, the oils and waxes become emulsified and are held

in emulsion, which limits the amount that may remain on the fabric, but are so distributed in evenness as not to affect the dye absorption rate of each fiber due to spotty concentrations of such oils and waxes.

Furthermore, creases and breaks, often occurring in materials when dyed according to present methods, are eliminated by the rapid passage of such material through the dye bath when the latter is maintained at temperatures substantially elevated above 212° F.

It is a further object of the invention not only to obviate the possibility of formation of fixed creases in the fabric, but to reduce substantially the time required to effect the dyeing operation and the cost thereof through elimination of the addition of chemical carriers and the expenses necessitated in the handling and disposal of such carriers.

A further object of the invention is to provide high temperature dyeing means which permit (with certain modifications) the use of standard developed dyeing apparatus and allow therewith the dyeing of all synthetics without limitation on the closeness of weave or on the quality of dye absorption and to provide "leveling" of dye uniformly.

The foregoing objects, features and advantages are attained by high temperature dyeing of fabric, composed either wholly and/or in part of synthetic material, e.g. Dacron, Kodel, Vycron, Mylar and the like, contrary to known practices, by passing the fabric in the form of a relaxed rope strand through a dye bath at temperatures substantially in excess of 212° F. This is attained by maintaining the dye bath under pressure in a pressure tight chamber. To expedite the process, the dye bath can be preheated at atmospheric pressures to a temperature ranging between 100° and 212° F. Thereafter the preheated dye bath with the fabric loaded in relaxed rope strand form is placed into a pressure chamber wherein the temperature of the dye bath is elevated to a temperature in substantial excess of 212° F., as for example in a temperature range between 240° to 255° F. Accordingly the interior of the pressure vessel is maintained under sufficient pressure to assure during the dyeing period the required elevated temperature of the dye bath therein. When temperature is reached, the fabric, as to relaxed rope strand, is then passed through the dye bath until the dyeing operation is completed. In the event the fabric is composed in part of a non-synthetic portion, the non-synthetic portion is subjected to a subsequent dyeing operation at atmospheric pressure and elevated temperatures, in the same apparatus.

A feature of this invention resides in the provision that the synthetic fabric can be dyed by passing the same in the form of relaxed rope strand through a dye bath under conditions of elevated temperatures at pressures above atmospheric without creasing and breaking.

The nature of the invention, however, will best be understood when described in connection with the accompanying drawings, in which:

FIGURE 1 is a transverse section, on an enlarged scale, through the pressure vessel with installed dye tub—the section being taken immediately within the door thereof—and a portion of the dye tub being broken away.

FIGURE 2 is a longitudinal section on a reduced scale, taken on the line **2—2** of FIG. 1 of the drawing.

FIGURE 3 is a schematic diagram of a multi-stage trackage arrangement for admitting of the mounting of the fabric in the dye tub externally of the pressure vessel, and unloading of dye tub externally of vessel after dyeing.

FIGURE 4 is an end view, on a reduced basis, illustrating the manner of introducing the dye tube into the pressure vessel.

In accordance with this invention the synthetic fabrics, e.g. polyester type fabrics, e.g. Dacron, Kodel, Vycron and the like are first prepared in the greige state as for conventional processing. The fabric is then heatset on any standard type of heat setting machine either in the greige or after boil off.

The fabric is then loaded onto a dye tub, preferably at an operating station which is outside of the pressure chamber which is to be used for dyeing in accordance with this invention. In accordance with this invention the fabric is loaded in the form of relaxed rope strands as individual strands, or as strands sewn end to end to form an endless rope which can be loaded onto suitable feeders in a spiral or corkscrew form, or as endless loops.

Preferably the temperature of the water of the dye bath is brought to 100° to 180° F. at a station outside the pressure vessel, and with the tub in operation the dissolved dye formula is added to the bath. The tub is operated for a time, approximately 15 minutes, to disperse the color thoroughly throughout the bath.

With the dye bath preheated, and the fabric loaded in rope fashion thereon, the tub is moved into the interior of a pressure chamber, and the chamber sealed pressure tight.

Steam is then introduced within the sealed pressure chamber to bring the temperature of the dye bath to a temperature in excess of 212° F. and a pressure in excess of atmospheric, while the dye tub is in operation. It has been discovered that an optimum temperature and pressure to effect optimum dyeing is in a range of 240°–255° F. at a pressure of approximately 17 lbs. At this temperature and pressure the dyeing cycle starts while the fabric as rope strand in a relaxed state is passed through the dye bath. The temperature and pressure of the chamber is maintained by regulation of suitable steam valves, and the dyeing cycle continued as long as necessary to attain desired shade, generally an hour and a half. If desired a sampling stick to which a sample of fabric is attached, may be employed to determine when the desired shade is obtained, and the degree of exhaustion of the dye liquor.

When the dyeing cycle has been completed, steam is shut off and cold water is admitted to the bath to cool the same. In cooling the bath it is essential to keep the temperature of the bath below the flash point in order to prevent the bath from boiling over and causing tangles. This is attained by regulating the pressure within the pressure chamber. The pressure is then gradually lowered by closing the steam valve, and ultimately opening the vent valve on the pressure chamber after the dye bath has cooled to 212° F. The dye tub is in continual operation through the process.

The addition of water for cooling will cause the level of the dye liquor in the tub to rise, but this is controlled by an overflow pipe and exhausted through steam traps.

If necessary addition of dye may be made during the dyeing operation by means of a small auxiliary vessel equipped with appropriate valves to control the pressure and the rate of such dye addition.

After all the pressure has been released from the pressure chamber, its closure is opened, and the dye tub removed, and positioned to a station exterior of the chamber.

If desired, the tub may be continued in operation at its external station either to complete the dyeing of the non-synthetic or other fibers of the fabric, or for washing and unloading.

The original loading process can then be repeated and the cycle repeated.

In a preferred procedure, it is desired to provide a plurality of dye tubs so that one tub may be loaded and operated upon exterior of the pressure chamber, as another tub is being operated within the pressure chamber. Thus loading, unloading, and dyeing can be simultaneously performed and thereby expedite the overall dyeing operation.

A preferred embodiment of an apparatus for carrying out the above described method for commercial application thereof is shown in the drawings.

Referring to the drawings, more particularly to FIG. 1 thereof, a pressure-sealable cylinder **10**, for example, resting on a supporting saddle **10'**, constitutes the pressure vessel or chamber in which a semi-cylindrical dye tub **11**

of novel design is placed. In this connection, it is to be noted that the tub is mounted on wheels **12**, which are designed to ride them along rails **13** located in the bottom of the pressure vessel to permit the tub to be freely introduced within the pressure vessel **10** and removed therefrom, as by rolling the said tub along the rails.

The pressure vessel **10**, furthermore, is equipped with supply lines **14**, **15** and **16** for supplying to the tub dye, water and steam, respectively. A perforated plate **17** may, also, be disposed along the length of the tub to prevent material from floating against the distributing piping and especially to prevent contact with concentrated dye.

A slatted reel **18** for the fabric and preferably of elliptical shape, is mounted on a rotatable axis **19** above the tub **11**, the axle being to this end supported rotatably on a platform member **20** in an imaginary off-center line along the length of the tub. The axle **19**, moreover, is designed for connection to a power source such as the electric motor **21**, FIG. 2, for rotation—the source being generally outside of the pressure vessel **10**, as is indicated.

The term "fabric" as used herein is intended to cover a length of cloth or strands, constituted in whole or in part of synthetic materials. It is to be noted that the fabric is placed on the slatted reel in the form of relaxed rope-like strands **22**.

In the dyeing of these, a length of fabric is introduced into the dye bath **30** in the form of an endless loop **22** traveling in one direction.

A slatted, idler reel **23** is carried on a further rotatable axle **24**, which is mounted on a platform member **25** secured to the tub; and it is disposed across from reel **18** above the said tub **11**. The idler reel **23** may be rotated by the looped fabric strands **22** themselves; but it is preferably power-driven, as in being connected with the axle **19** as through a chain drive **26** located externally of the tub **11**. An intermediate folding of the rope strands or loops **22**, as is indicated in FIG. 1, will then be effected as the fabric passes from reel **18** to the floor of the tub in the dye liquor.

A port hole **27** and one or more pressure-relief valves **28**, as well as a vacuum-breaker valve **28'**, are provided in the cylinder **10**, as shown. Furthermore, an external sampling tube **29** is provided and extends therethrough into the dye bath **30**.

The dye tub **11** is provided, also, with one or more drains, as the drain **32** which is positioned then below, at its one end, a false bottom **33** of the tub; and at its other end connects with an overflow outlet gutter **34**—as through pipe **35** conveying overflow liquor therefrom.

The pressure vessel **10**, moreover, is equipped with an airtight door **36**, FIGS. 2 and 3, which is suitably mounted at one end of said vessel to establish a tight fit therewith during operation.

In FIG. 2, the fabric is indicated as divided into the plurality of relaxed rope-like, endless strands **22**, of one of more pieces, the strands **22** being mounted over the reel **18** and idler **23** and arranged to dip into the dye bath **30**. However, the fabric strands may be either in the form of one piece or several pieces.

Upon sealing then the pressure vessel at the door **36**, the temperature of the bath **11** is elevated to the required degree, for example 250° F. in the case of Dacron, by introducing steam into the sealed vessel through the supply line **16**. Thereupon motor **21** is energized for rapid approximate (160 ft. per minute) advance of the material through the said bath as relaxed rope strands until the desired shade is obtained.

The power source **21**, as hereinbefore noted, may be carried by the pressure vessel, preferably externally thereof, as shown; and is connected to axle **19** through a stuffing box **37** and dog clutch **38** for power engagement.

Rake rods or bars **39** are also provided so that each rope-like strand will pass between a set of the same and thus be prevented from entanglement while circulating through the dye bath.

The ends of the respective strands of fabric are connected to provide the continuous endless loop which is to be passed over the rotating reel **18** and idler **23**, as shown. The shape of the reel, however, is not critical; but it is desirable to provide a shape which will prevent slippage of the fabric and thus insure uniform folds.

In practice the fabric is mounted on the reel and idler, and the dye tub filled with the dyeing liquor. The temperature of the dye bath is then pre-heated to about 180° F.–212° F., for example, at a station external the pressure vessel. Also with reference being had to FIGS. 3 and 4 of the drawings, the fabric is mounted on the tub, e.g. at station A as aforesaid, for subsequent passage through the dye tub **11**.

The tub through its wheels **12** is supported and rides on tracks **40**, which extend adjacently and parallel to the tracks **13** (not shown) located within the cylinder **10**. A carriage **41** is designed to travel on tracks **42**, through supporting wheels **43**—after receiving the dye tub **11**—for delivery of said tub into the interior of pressure vessel **10**. The tracks **42** to this end are directed at right angles to the tracks **40**; and an intermediate track section **44** is provided at the pressure vessel **10** and aligned with the tracks **13** (not shown) therein.

It will be understood that other means (not shown) to transfer the dyeing apparatus into and out of the dyeing apparatus may be employed, for example, such as monorails or castors or the like in place of the said tracking arrangement shown.

When the dyeing at elevated temperatures within the pressure vessel or chamber has been completed and the dye tub is to be withdrawn, the latter is brought beyond the pressure vessel over track section **44** onto the carriage **41** after lowering pressure and temperature; and it may then be shifted by the latter laterally to convey the tub to a further set of tracks **40'**—which are located at the opposite side of the pressure vessel—by moving said carriage accordingly, for further disposition of the tub unit. Other types of dye tubs may, of course, be similarly introduced.

In the event the fabric, which has just gone through the dyeing cycle within the pressure vessel also contains fibers of a non-synthetic form, or fibers other than a polyester, such fibers can be dyed in a subsequent dyeing cycle at an external station by passing the fibers through the dye bath at elevated temperatures and atmospheric pressure. In this manner a fabric containing distinct fibers can be dyed in a two cycle operation in the same apparatus.

While the instant invention has been described in detail with reference to a particular method, and a preferred form of an apparatus for practicing the same, it will be understood that variations and modifications thereof may be practiced without departing from the spirit or scope of the invention.

What is claimed is:

1. A method of dyeing fabrics comprising polyester fibers comprising the steps of:

(a) loading an endless loop of said fabric in an exposed and unconfined manner on a suitable feeding means which is carried on a tub for containing a dye bath,

(b) filling the tub with a dye bath,

(c) elevating the temperature of the dye bath to a temperature ranging between 180° F. and 212° F. at atmospheric pressure and circulating the loop of said fabric through said dye bath as said dye bath is being brought up to said temperature,

(d) positioning said heated dye bath and partially dyed fabric into a pressure tight chamber,

(e) sealing the dye bath and fabric pressure tight in said pressure chamber,

(f) elevating the temperature of said dye bath within said pressure chamber to a temperature of approximately 250° F. by introducing steam within the sealed vessel, and

(g) continuously feeding the endless loop of fabric free of restriction through said dye bath at said elevated temperature until the dyeing operation is completed whereby intermediate folding of the fabric occurs in the dye bath during said operation,

(h) gradually cooling down the dye bath by reducing the temperature and pressure within the pressure vessel in a manner wherein the pressure is maintained to prohibit boiling of the dye bath, and

(i) removing the dye bath and material from the pressure vessel upon the gradual cooling thereof.

2. A method of dyeing fabric comprising in part of thermoplastic hydropholic synthetic fibers and comprising the steps of:

(a) loading the fabric to be dyed on suitable feeding means in the form of relaxed rope strands,

(b) preparing a dye bath,

(c) preheating the dye bath to a temperature between 100° F. and 212° F., and circulating the relaxed rope strand through said dye bath as it is being brought up to said temperature at atmospheric pressure,

(d) positioning the preheated dye bath and partially dyed relaxed rope strands into a pressure tight chamber and sealing the chamber,

(e) elevating the temperature of the dye bath within the sealed pressure chamber to a temperature above 212° F. by introducing steam in said pressure vessel,

(f) maintaining the pressure within the pressure vessel during the elevation of the temperature of the dye bath at a point to prevent evaporation,

(g) and feeding the fabric of relaxed rope strands in an unconfined manner through the dye bath at said

elevated temperatures until the pressure dyeing portion of the operation is complete,

(h) lowering the pressure in chamber to atmospheric pressure in such manner that the temperature of the bath is maintained below its flash point, while cooling,

(i) remoging the dye bath and dyed fabric from the pressure chamber,

(j) moving to external operating station to continue dyeing by,

(k) subjecting the non-synthetic portion of the fabric to the dye bath at substantially atmospheric pressure and elevated temperatures.

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8—151, 152, 158