Aug. 14, 1956 L. J. CLARKE 2,758,463

APPARATUS FOR WET PROCESSING TEXTILE MATERIALS

Filed Dec. 27, 1951 4 Sheets-Sheet 1

FIG. 1.

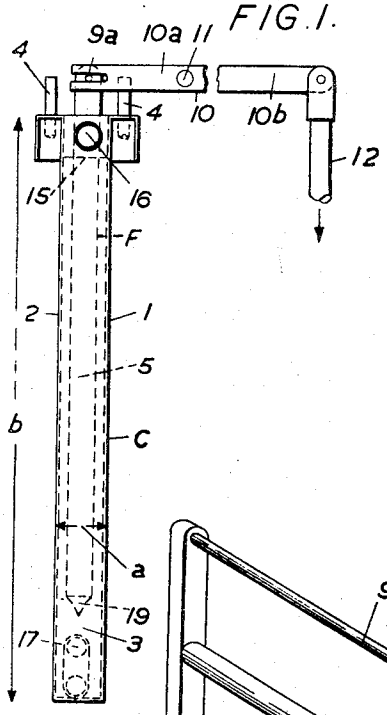


FIG. 2.

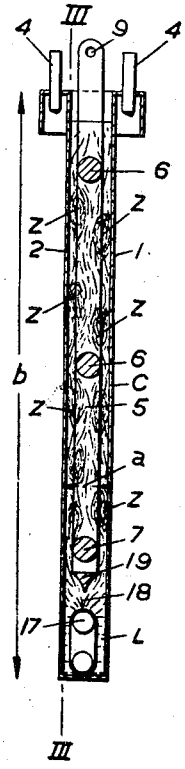
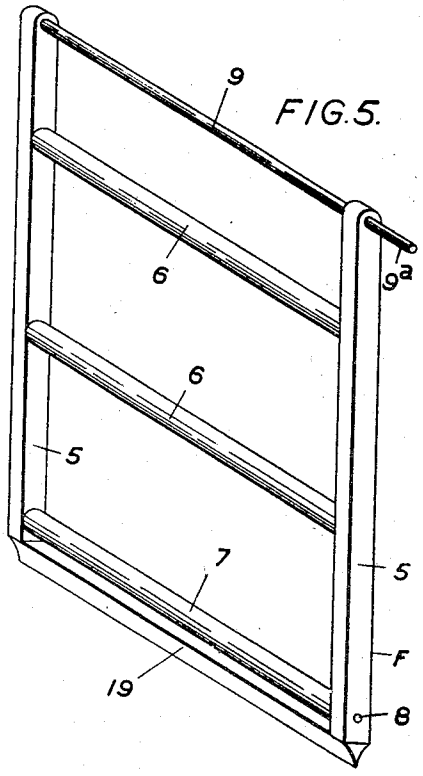


FIG. 5.



Inventor
Leslie J. Clarke
By
Cromwell, Parker & Ogle
Atty.

Aug. 14, 1956 L. J. CLARKE 2,758,463

APPARATUS FOR WET PROCESSING TEXTILE MATERIALS

Filed Dec. 27, 1951 4 Sheets-Sheet 2

FIG. 3.

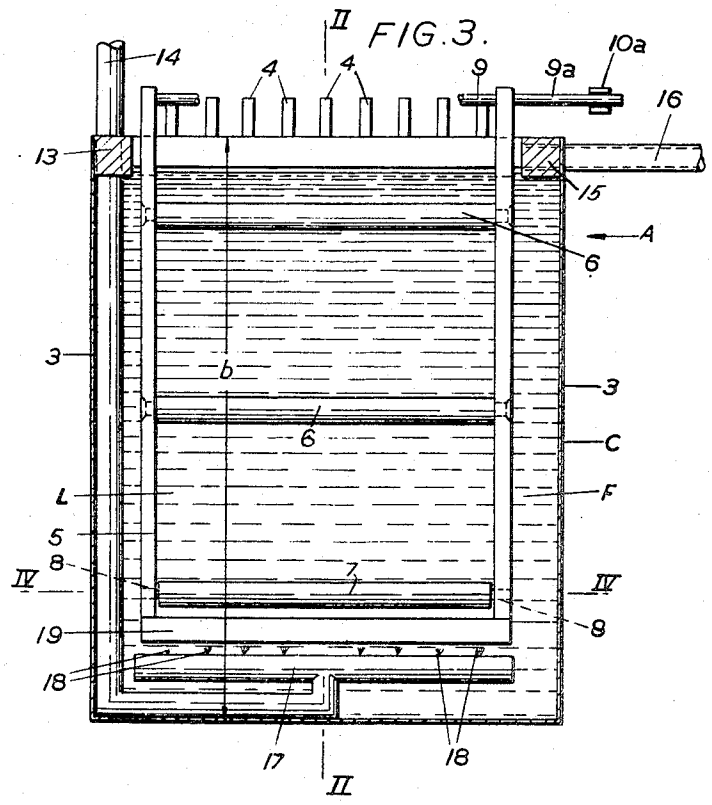
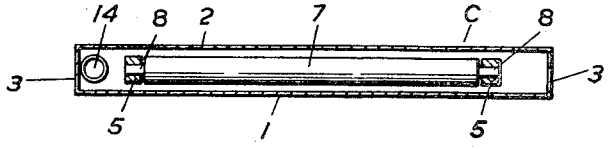


FIG. 4.



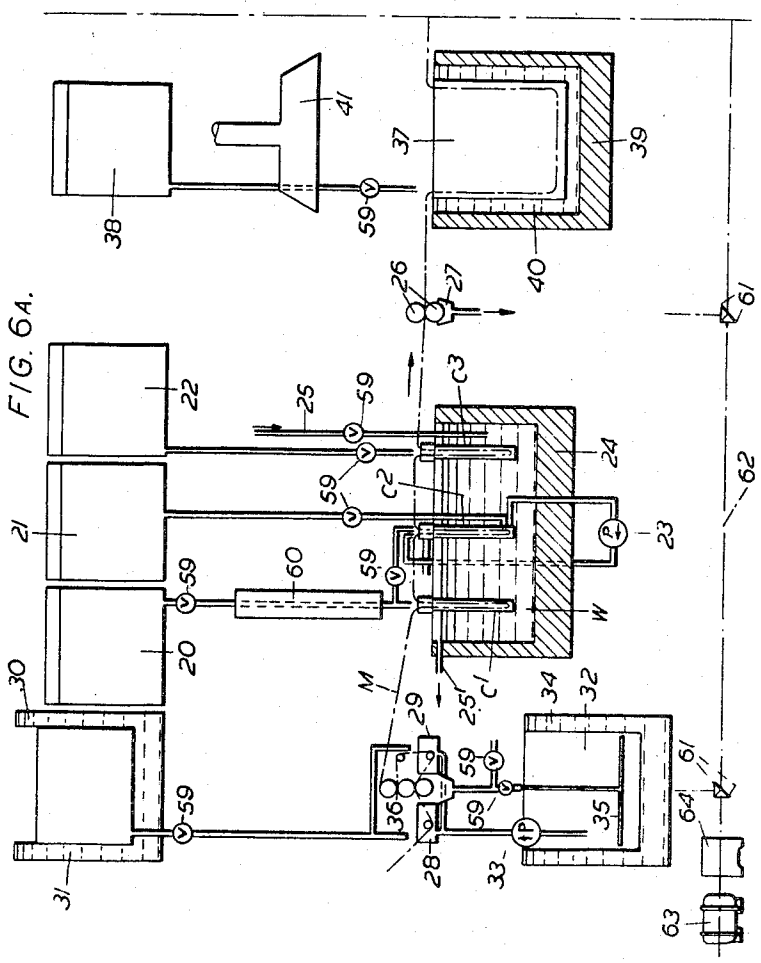
Inventor
Leslie J. Clarke
By
Samuel Pasche
Atty.

Aug. 14, 1956 L. J. CLARKE 2,758,463

APPARATUS FOR WET PROCESSING TEXTILE MATERIALS

Filed Dec. 27, 1951 4 Sheets-Sheet 3

FIG. 6A.



Inventor
Leslie J. Clarke
By
Jerome A. Parker
Atty.

Aug. 14, 1956 L. J. CLARKE 2,758,463

APPARATUS FOR WET PROCESSING TEXTILE MATERIALS

Filed Dec. 27, 1951 4 Sheets-Sheet 4

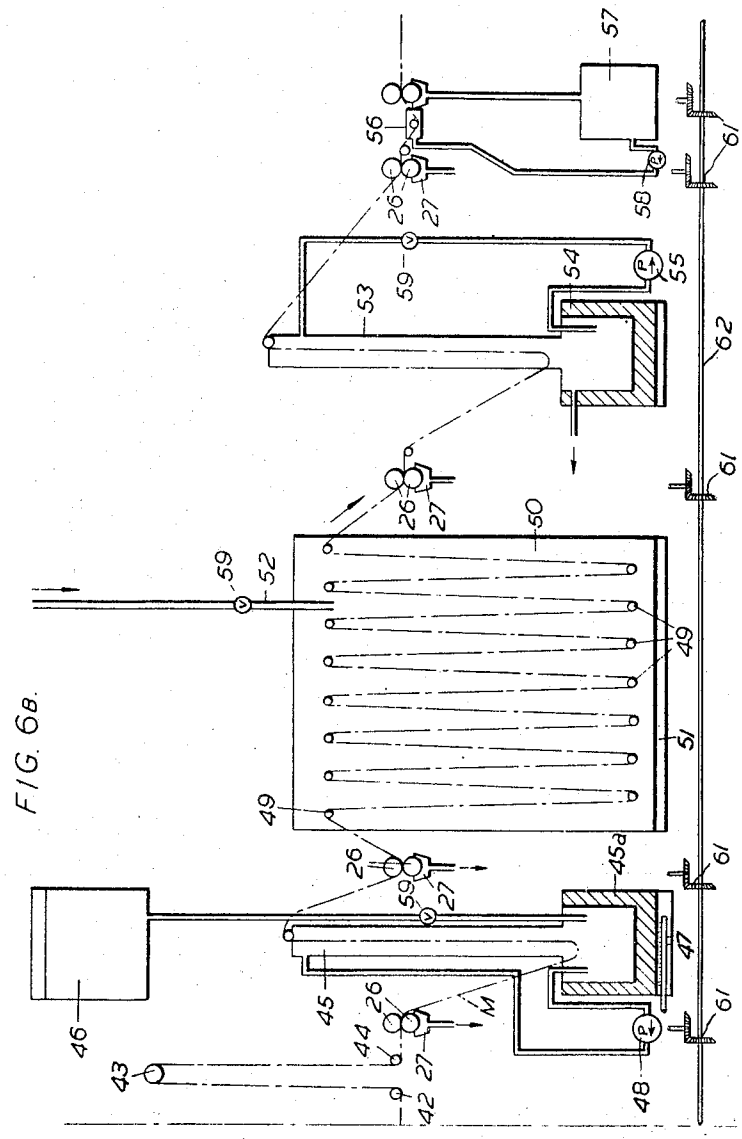


FIG. 6B.

Inventor
Leslie J. Clarke
By
Attorney

United States Patent Office 2,758,463 Patented Aug. 14, 1956

2,758,463

APPARATUS FOR WET PROCESSING TEXTILE MATERIALS

Leslie James Clarke, Kenilworth, England

Application December 27, 1951, Serial No. 263,535

2 Claims. (Cl. 68—175)

This invention relates to a method of and apparatus for wet processing textile materials.

Thus, although the invention is principally concerned with the dyeing, bleaching or analogous treatment such, for instance, as the impregnation with finishing agents of woven or knitted webs or ribbons and other textile fabrics of any width, it is by no means limited in this respect as it may, for instance, also be employed for use in the similar treatment of cotton and other yarns or threads, e. g. rayon, produced by a continuous spinning process.

The principal processes heretofore adopted for dyeing textile materials can be divided into three classes, viz.

(*a*) Laborious and costly processes in which the goods to be dyed are entered in bulk and heated or boiled, for a comparatively long time in a large tank or vat containing liquor made up of water and dye powder calculated on the basis of fabric weight. During such a process tests are carried out and variations of the composition of the liquor effected as occasion demands. Each time the composition requires to be varied or the liquor reheated, however, it is necessary first to remove the goods from the tank or vat and to re-enter them after the adjustment has been made.

(*b*) Processes involving the use of a dye jigger or a winch dyeing or like machine and in which the goods are passed back and forth through dye liquor contained in a tank or vat.

(*c*) Processes in which the goods are put into a tank or vat, e. g. of cylindrical form, and the dye liquor is circulated under pressure.

In all such prior processes, the maximum quantity of fabric or yarn which can be dyed is, of course, limited by the capacity of the tank or vat used. This necessitates dealing with more than a tank full of goods in a plurality of separate batches, in which connection difficulty is experienced in obtaining uniform dyeing conditions—owing to variations, however slight, not only in the concentration of the dye liquor, but also in the water hardness, the temperature, and so on, as between one dyeing operation and another. Moreover, in such processes the dye liquor is worked to exhaustion and difficulties arise from the varying rates at which different dyes build up on the fibre. Consequently, in mixture colors the ideal balance between the components may be obtained only at one particular stage, and if the depth of shade is not at that moment correct, then any variation in depth of color due to longer immersion will naturally result in the component colors being out of balance. Although appropriate selection of dyestuffs having equal speeds assists in obviating this difficulty, the selection is obviously limited.

The object of the present invention is to provide an improved process and apparatus for rapidly and efficiently dyeing or analogously treating textile materials which process and apparatus are designed not only to overcome the aforementioned difficulties, but also to provide further advantages as will be hereinafter described.

Broadly considered, the improved process consists essentially in passing textile material in continuous length uni-directionally through at least one cell or zone containing a small volume only of treating liquor and so dimensioned as to provide an extended path for the material therethrough, the liquor in the cell being regularly changed and kept in motion throughout the process.

In the preferred manner of carrying out this process, the material to be treated is continuously passed uni-directionally through a plurality of such unit cells in succession.

For the sake of convenience in the following further description, the process and the apparatus for carrying out the same will be described with reference to dyeing—it being understood, however, that this term is used generically and is intended to include, where the context so admits, analogous wet processing as aforesaid.

The or each unit cell may advantageously be so dimensioned and disposed that the material to be dyed, in being caused to pass through and be immermsed in the cell, follows a vertical or substantially vertical and relatively long U-shaped path. This ensures that each of successive portions of the materials shall be immersed in the liquor in the cell for a sufficient length of time for the purpose in view.

In carrying out the improved dyeing process, moreover, the concentration of the dye liquor will usually have to be abnormally high.

As previously mentioned, an essential feature of the process is that the liquor in the or each unit cell is kept in motion. To this end, zones of turbulence passing with wave-like motions through the body of the liquor in the cell, may be created by suitable injection of liquor. Such turbulence, which may simulate the agitation of a liquor caused by boiling or the use of mechanical impellers, paddles or the like, has an accelerating effect on the dyeing process. In the preferred manner of carrying out the improved process, the injected liquor causing the turbulence is also the replenishment charge, this ensuring a continuous supply of homogeneous liquor at all times and for an indefinitely long period.

It may prove to be desirable to expel surplus fluid from the material during its passage from one cell to the next, thereby bringing the material into a condition capable of receiving more dyestuff.

The improved dyeing process may advantageously be followed without interruption by finishing processes such as drying and ironing.

With regard to the apparatus for carrying out the hereinbefore described process this includes, in combination, at least one relatively deep and narrow cell or zone adapted to contain a small volume only of treating liquor, means within the said cell for guiding material in continuous length through the cell in an extended U-shaped path, means for regularly changing and creating turbulence within the contained liquor, and draw means for causing the material to travel uni-directionally through the cell.

As will be appreciated from the foregoing description of the process, the apparatus preferably comprises (and will hereinafter, without limitation, be regarded as so comprising) two or more of the small unit dyeing cells.

Each of the cells is of box-like form and may conveniently incorporate a removable depressor frame which, in use, is immersed in the liquor in the cell and is fitted with a roller around which the material is passed and by which it is guided.

In order that the invention may be more clearly understood and readily carried into practical effect, a specific form of the aforementioned cell and removable depressor frame, and also a complete continuous dyeing apparatus

incorporating a series of such cells will now be described with reference to the accompanying drawings, wehrein:

Figure 1 is an end view of a wet processing cell and depressor frame as seen in the direction of the arrow A in Figure 3,

Figure 2 is a vertical sectional view of the said cell and frame taken on the line II—II of Figure 3,

Figure 3 is a transverse sectional view of the same taken on the line III—III of Figure 2,

Figure 4 is a sectional plan view of the cell and depressor frame taken on the line IV—IV of Figure 3,

Figure 5 is a perspective view of the depressor frame per se, and

Figures 6A and 6B together constitute a diagram, partly in section, of the continuous dyeing apparatus.

Like parts are designated by similar reference characters throughout the drawings.

Referring to Figures 1–4, it will be seen that the illustrated zone or cell C is of flat box-like form, being relatively deep, narrow from its front side **1** to its rear side **2** (i. e. in the general direction of forward travel of textile material passed through the cell), and of a width between its narrow sides **3**, either commensurate with the width of the fabric, or dependent on the number of separate ribbons, webs, yarns or threads, to be dyed. In its position of use the cell is vertically disposed and open at its upper end only. By reason of this disposition of the cell C, liquor L contained therein will have a minimum surface area from which there will be comparatively little loss of heat. In regard to vat dyes, these tend to oxidize prematurely on the surface of liquor, thereby forming an undesirable scum; accordingly, the small surface area exposed in the cell also avoids this difficulty. The relatively narrow dimension *a* of the cell from front to back (Figures 1 and 2) imposes the desired restriction on the volume of the contained liquor L, while the depth *b* of the cell determines the length of the extended path of the material therethrough and hence also the period of immersion of the material.

Where the goods to be processed consist of separate ribbons, yarns or threads these are guided from cell to cell by series of suitably spaced pegs or pins such as **4** carried in appropriate fixed portions or members at the top of each cell. Thus, in the specific example shown, the pegs or pins 4 are vertically disposed and set in inverted channel section formations provided along the top edges of the front and rear sides **1** and **2** of the cell C. In this regard, nine pairs of such pegs or pins are shown in the drawings to take eight ribbons, although this number may, of course, be varied according to requirements.

Within the cell is mounted a removable depressor frame indicated generally at F, this frame, in use, being immersed in the liquor L. The depressor frame F, as depicted more clearly in Figure 5, comprises two vertical side members **5** which are rigidly connected and spaced apart parallel to each other by spacer bars **6** of circular cross-section. Near to its lower end the said frame is fitted with a horizontally disposed and freely rotatable roller **7** which is either mounted upon a spindle or is provided at its ends with trunnions **8** arranged to turn in bearing holes formed in the side members **5**. At their upper ends, the two side members **5** have secured therein a top rail **9** which at one end **9***a* extends beyond the corresponding side of the frame for a purpose presently to be described. Thus, material passing through the cell first extends vertically downwards nearly to the bottom of the cell, then around the roller **8** of the depressor frame and finally vertically upwards—being guided both by the said roller and also by the spacer bars **6**. Accordingly, the depressor frame F serves to hold the travelling material down and maintain its U-shaped path in the cell.

To compensate for continuous shrinkage of material during its travel through the cell C, in a case where such shrinkage takes place, the depressor frame F may be suitably counterpoised or counterweighted and adapted to rise as shrinkage takes place, such upward movement of the frame being utilised to effect actuation of speed control means, through the medium of intermediate connections of any appropriate character. In this way the travelling material can be maintained at so small a tension that, for instance, even wet viscose rayon will not be stretched in a harmful manner. In this connection, the aforementioned extended end **9***a* of the top rail **9** may, as illustrated in Figure 1, be engaged in a slotted arm **10***a* of a two-armed lever **10** which is arranged to fulcrum about a fixed pivot **11** and has its arm **10***b* connected, by means of a link **12**, with either a counterpoise weight or speed control means.

In the top of the cell at one side thereof is fixed a small block **13** through which extends a vertically disposed portion of a feed pipe **14** for the liquor L. At the opposite side of the cell is fixed a similar block **15** for the support of the appropriate end of an overflow pipe **16**.

For simultaneously changing and creating turbulence in the liquor L there is provided in the bottom of the illustrated cell C a pipe **17** through which liquor from the feed pipe **14** is supplied and permitted to escape in the form of small jets **18** (see Figures 2 and 3) through a series of holes in the pipe **17**. In association with the pipe **17** there is provided deflector means against which the streams of injected liquor strike and divide. Although in this regard there may be a separate deflector to each jet, it is preferred to provide, as shown more clearly in Figures 3 and 5, a single elongated deflector **19** common to the entire longitudinal series of jets **18**. In either event, the deflector or each deflector in the cell may in cross-section be either V-shaped or, as is the deflector **19**, of solid triangular form. Any other suitably shaped deflector may, however, be adopted. According to the shape and size of the or each deflector, the pressure of the jets, and the distance between the jets and the deflector or deflectors, varying degrees and types of turbulence can be created, the zones Z of turbulence (Figure 2) in any case passing with wave-like motions right up to the top of the cell. Moreover, the angle between the walls of the cell (if off the vertical) will affect the angle at which the zones of turbulence will be reflected. The effect of the turbulence is to maintain the liquor L immediately adjacent to the fabric in motion so that exhausted liquor is removed and replaced by active liquor at high frequency but without risk of damage to the fabric by mechanically moving parts.

Injection may be continuous or intermittent. In the latter case the liquor may be delivered by a pump the piston of which is adapted to be actuated by cam means so that a slow charging stroke and rapid discharge stroke may be obtained, or, alternatively, the liquor may be under continuous prressure and the rate and frequency of the injection controlled by cam operated valves or equivalent.

Since each cell C contains only a relatively small volume of liquor, little power is required to produce the necessary turbulence.

The volume of liquor in the cells or each cell being relatively small (say anything from 1 to 3 gallons) and, in view of the fact that the liquor is regularly changed, a continuous dyeing action is possible. In fact, there is no limit to the quantity of goods which may be uninterruptedly dyed. The process may accordingly be continuous throughout the day and night. The regular changing of the treating liquor in the or each cell may be effected either continuously, i. e. without interruption, or intermittently. In any event, the changing of the liquor in this way makes good the progressive exhaustion of the latter, thereby maintaining the concentration constant.

The process within this invention can be a rapid one, dyeing taking place in anything from, say, 10 to 120 seconds, even where deep tones are required. During this comparatively brief period, differences in speed of dyeing with mixture dyes do not become manifest to any appre-

ciable extent. But if extra dyeing time is required, e. g. when using slow acting dyes or when it is desired to build up very heavy shades, then such extra time may be secured by using two or more cells in series to give suitable passages of the material through the liquor. It is, however, to be clearly understood that even such an extended dyeing time would still only be a fraction of the time taken in a normal dyeing process. As an alternative to the use of a plurality of cells in such cases as those specified, the desired results might be obtained by increasing the degree of concentration of the liquor, although in this connection it has to be borne in mind that difficulties and faulty work may result from over-concentration.

Where, as is preferred, the process consists in passing textile material in continuous length unidirectionally through a plurality of the unit cells, the material can pass from one cell to another, and if necessary, be given a series of different chemical treatments without handling.

Furthermore, different phases, stages or sub-processes of a complete process may be linked together (without handling of the material) by carrying them out in respectively different cells. To quote one specific example, in cases where it is desired to dye material in azoic (naphthol) colors the material may be impregnated with one chemical in one cell, and the color developed in another chemical in another cell, and so on. Again, in the case of vat dyes the dyestuff requires to be converted into an alternative chemical form known as the "leuco state," so as to enable the dye molecules to penetrate within the fibres. After such penetration has taken place, the application of an oxidizing agent turns the dye back into its original form and color. In the case of pigment padding, the fabric is charged with dye powder as a suspension in water and then passes into a chemical bath where the dyestuff is reduced and dyeing takes place, followed by oxidation. Such a chain of reactions may advantageously be carried out in cells of the form provided by this invention.

The specific continuous dyeing apparatus illustrated diagrammatically in Figures 6A and 6B incorporates, merely by way of example, three unit dyeing cells C^1, C^2 and C^3 each of the character hereinbefore described. As shown, the first two of these cells—C^1 and C^2—are arranged in tandem and supplied with reduction solution from two separate tanks **20** and **21**, the third cell, C^3, being separately supplied with a brine solution from a tank **22**. This particular arrangement may, however, be varied, any other two or all three of the cells being suitably connected. In fact, the cells may be used in series or in parallel, or each cell of the set may be independent of the others so far as the source from which it derives its liquor. The material passed in continuous length unidirectionally (i. e. in the direction of the arrows in Figures 6A and 6B) through the cells is indicated at M. In Figure 6A, there is depicted at **23**, in purely diagrammatic fashion, a pump for continuously injecting reduction solution from the tank **21** into the cell C^2 at the pressure necessary to produce the required turbulence therein. Although for the sake of simplicity in illustration, no such means are shown in conjunction with either of the cells C^1 and C^3, it is to be clearly understood that, in practice, either the same pump **23** or separate pumps would be employed to create turbulence in all three cells.

In accordance with an important further feature of the apparatus, the cells C^1, C^2 and C^3 are shown mounted in a comparatively large insulated tank **24** for containing hot water and thereby enabling the temperature of the aforementioned reduction and brine solutions to be maintained substantially constant. The tank **24** is fitted both with a water supply pipe **25** and also with a drain pipe 25^1. The water W in the said tank may be re-heated while dyeing is in progress, thus obviating the difficulty of removing the material from the liquor while adjustments for temperature or composition are being made. The rapidity with which dyes react on fibers is very much affected by temperature, and slight variations may cause changes in the depth of tone.

Maintenance of the dye liquor at a high temperature of from, say, 90°–100° C. is often desirable, principally because the chemical exchanges between the liquor and the fiber are more rapid when heat is applied. There are, however, cases where lower temperature may be desirable, and in the case of azoic colors cold working is essential.

A pair of draw rolls, one or both of which may be positively driven, may be provided for continuously drawing material through the cells. If necessary or desirable, a roller may be stationed in advance of the first cell of a series to assist the continuous travel of the material.

Suitably driven pairs, or groups each of, say, three mangling rollers, preferably with associated drip troughs, may advantageously be provided for the purpose of expelling surplus liquor from the travelling material during its passage from one section of the apparatus to the next. Experience shows that it may be advantageous to use a combination of different materials for the rollers, such, for instance, as two of rubber and one of metal, e. g. stainless steel, or two of metal and one of rubber, or, in the case of a pair, one of each material. In lieu of metal, any suitable hard material, such as vulcanite, may, if desired, be used. Alternatively, suction or equivalent devices may be furnished for the same purpose. Thus, in the particular apparatus illustrated, pairs of driven mangling rollers **26**, each with an associated drip trough **27**, are provided between successive sections, these rollers serving also as the draw means for causing the material M to travel through the apparatus.

The specific apparatus shown, by way of example, in Figures 6A and 6B will now be more fully described.

As arranged, the apparatus is suitable for carrying out "pigment padding," although it is to be understood that for other dye techniques such as direct colors, azoic colors, and so on, the arrangement, including the grouping of the cells, may vary widely according to particular requirements. Referring first to Figure 6A, it will be seen that in advance of the first dyeing cell C^1, the material M is passed successively through two baths **28** and **29** supplied with dye (pad) liquor in an unreduced state from a pre-heated tank **30** surrounded by a hot water jacket **31** the temperature of which is suitably controlled. The said liquor is contained in a reservoir **32** and circulated by a pump **33**. The reservoir **32**, which is surrounded by a hot water jacket **34**, has mounted therein a reciprocating agitator **35**. Between the two baths **28** and **29** there is provided a group **36** of three mangling rollers. After subsequently passing through the two cells C^1 and C^2 containing reduction solution as aforesaid, the travelling material M passes through the brine cell C^3, then through a pair of the mangling rollers **26**, and next through a reservoir **37** arranged to be supplied with oxidation liquor from a supply tank **38**. This tank is mounted in an outer insulated container **39** between which and the said tank is a hot water jacket **40** the temperature of which is controlled. Above the oxidation reservoir **37** is located a fume hood **41**. From the reservoir **37**, the travelling material is guided around rollers **42**, **43** and **44**, from whence it is drawn through another pair of the mangling rollers **26** and thereupon passed through a tower **45**. Therein it is subjected to the rinsing action of warm water and a neutralizing solution fed into this structure from a tank **46**. A reservoir **45***a* at the lower end of the tower **45** is equipped with a heater **47**, and a pump **48** is provided for circulating the rinsing liquid. Proceeding on its way, the rinsed material, after being drawn through a still further pair of mangling rollers **26**, travels alternately over and under series of guide rollers **49** housed in a soaping-off tank **50** equipped with a heater **51**. The supply into the tank **50** is by way of a pipe **52**. Next, the material M travels upwards

through a second rinsing tower **53** similar to the tower **45**, this being combined with a reservoir **54** and fitted with a pump **55**. Finally, the material is fed through a finishing pad trough **56** through which a suitable finishing agent from a tank **57** is circulated by a pump **58**.

Throughout Figures 6A and 6B variable control valves incorporated in the piping are indicated diagrammatically by crosses at the points marked **59**. Referring again to the tank **20**, the down pipe therefrom is fitted with an electric pre-heater **60**.

The water heaters may be of any convenient form, e. g. thermostatically controlled gas heaters.

All of the rollers **26** and, if desired, any other feed rollers, may conveniently be driven, through bevel gearing **61**, from a common shaft **62** running underneath the entire apparatus so that the relationship between the speeds of all the separate parts can be maintained at fixed ratios. The shaft **62** is driven by an electric motor **63** through the medium of variable speed gear at **64** (Figure 6A).

As the apparatus of this invention precludes the "creeping approach" method of obtaining accurate shades, it is necessary that it shall include provision for effecting an overall variation in speed, so that the time of passage of material through an individual cell can be adjusted up or down to give intermediate times arising from one, two or three cells.

One convenient method proposed to be used in this connection is based on colorimetric valuation which can readily be carried out visually, for instance, by continuously taking a small sample of the dye liquor and circulating it through a glass cell, whereupon the operator can make the necessary readjustments to the apparatus to vary the speed of travel of the material to the required extent. A possible alternative method of obtaining accurate shades is by estimation of the chemical salt content of a liquor by measuring its electrical resistance which varies proportionately to the concentration. In this regard, variations in the volume of current passing may be utilized to actuate either speed controls or valves. Thus by the adoption of such expedients effective action can be taken to remedy an incorrect shade, and, in any event, the necessary adjustments may advantageously result in variation of the speed of the main driving shaft **62**. Without such control, an incorrect shade could be corrected only by re-blending the whole of the dye liquor intended to be used for a given run.

If, as may be, the dyeing apparatus is combined with a finishing section including, for instance, infrared or warm air heating means, a heated finishing plate and associated guide and draw rollers, then this section would require to be appropriately correlated with the dyeing section to enable continuous dyeing and finishing to take place.

A special advantage of the improved process in the case of continuous spun rayon yarn is that by means of suitably geared rollers the yarn can be fed into the dyeing liquor in a relaxed condition so as to allow for the 5% shrinkage which must take place when wetting out occurs. It is possible, therefore, to dye under virtually tensionless conditions, and after passing through the requisite series of cells the yarn may be dried still in a relaxed condition and wound up into suitable packages.

What I claim is:

1. Apparatus for carrying out a process of wet treatment of textile material comprising, in combination, at least one relatively deep and narrow cell for containing a small volume of treating liquor, means within the said cell for guiding textile material in continuous length through the cell in an extended U-shaped path, a pipe which is fitted in the cell below the guide means and has formed therein a series of small holes, means for regularly supplying liquor under pressure into the said pipe so that such liquor escapes therefrom in the form of jets, deflector means associated with said pipe and against which the jets of injected liquor strike and divide so as to produce zones of turbulence passing with wave-like motions through the body of liquor contained in the cell, and draw means for causing the material to travel in the U-shaped path within the cell.

2. Apparatus according to claim 1, wherein the said deflector means is a single elongated deflector of triangular form in cross section, the said deflector being common to all of the holes formed in the pipe.

References Cited in the file of this patent

UNITED STATES PATENTS

241,464	Wilkinson	May 10, 1881
472,327	Auger	Apr. 5, 1892
1,402,765	Haskell	Jan. 10, 1922
1,539,709	Wood	May 26, 1925
1,612,698	Cohoe	Dec. 28, 1926
1,683,325	Berg	Sept. 4, 1928
1,801,513	Lindberg	Apr. 21, 1931
1,896,954	Heap	Feb. 7, 1933
1,940,748	Gwaltney	Dec. 26, 1933
2,108,188	Batchelder	Feb. 15, 1938
2,118,807	Carter	May 31, 1938
2,203,678	Dursteler	June 11, 1940
2,210,880	Capstaff	Aug. 13, 1940
2,219,490	Pisarev	Oct. 29, 1940
2,292,511	Ferm	Aug. 11, 1942
2,344,557	Mann et al.	Mar. 21, 1944
2,364,838	Williams	Dec. 12, 1944
2,445,504	Williams	July 20, 1948
2,532,326	Naumann	Dec. 5, 1950
2,552,078	Williams	May 8, 1951

FOREIGN PATENTS

568,627	France	Dec. 24, 1923
5,874	Great Britain	A. D. 1911
609,728	Great Britain	Oct. 6, 1948

OTHER REFERENCES

Walter article in "The Textile Colourist and Finisher," March 1951, pp. 136–139. (Copy in POSL and 8–151.)

The Textile Manufacturer, March 1945, pp. 124. (Copy in POSL.)