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Luckenbach et al.

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[45] **Apr. 29, 1975**

[54] **METHOD FOR DYEING TEXTILES**

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[73] Assignee: **Burlington Industries, Inc.**, Greensboro, N.C.

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[21] Appl. No.: **410,549**

Related U.S. Application Data

[62] Division of Ser. No. 237,683, March 24, 1972, Pat. No. 3,785,180.

[52] **U.S. Cl.** **8/158**; 68/15; 68/184; 68/207; 68/210

[51] **Int. Cl.** **B05c 8/02**

[58] **Field of Search** 8/158; 68/15, 16, 184, 68/207, 210

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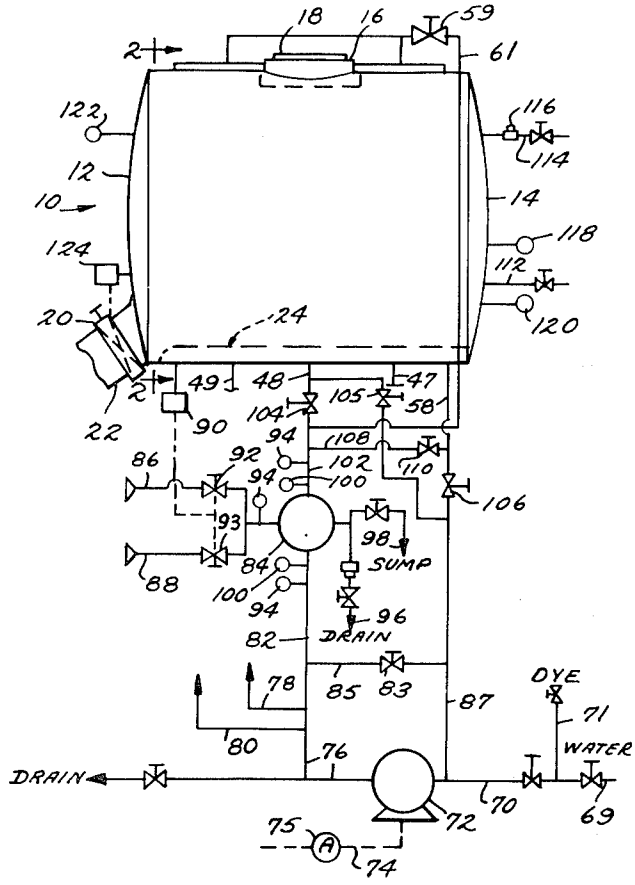
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Assistant Examiner—Philip R. Coe
Attorney, Agent, or Firm—Cushman, Darby & Cushman

[57] **ABSTRACT**

The disclosure embraces a method of dyeing and an apparatus comprising a horizontally extending generally cylindrical article dyeing vessel which is provided with a bank of nozzles extending along the interior bottom wall portion of the vessel; the nozzles are disposed to discharge liquid in a generally tangential direction with respect to the interior of the vessel; the nozzles are divided into groups each of which is connected to the out-put of a pump through one or more conduits. The conduit or conduits which deliver fluid to the nozzles are provided with a valve means so that the output of the nozzles can be controlled whereby a substantially uniform, circular fluid flow may be obtained. The vessel is provided with a suction liquid outlet slot on one side of the nozzles opposite the direction of fluid delivery and which extends the length of the vessel to enable the vessel to handle variably sized loads. A large unloading valve is provided to enable the vessel to be rapidly emptied and fluid nozzles are arranged on the interior of the vessel to flush articles out through the unloading valve.

3 Claims, 6 Drawing Figures



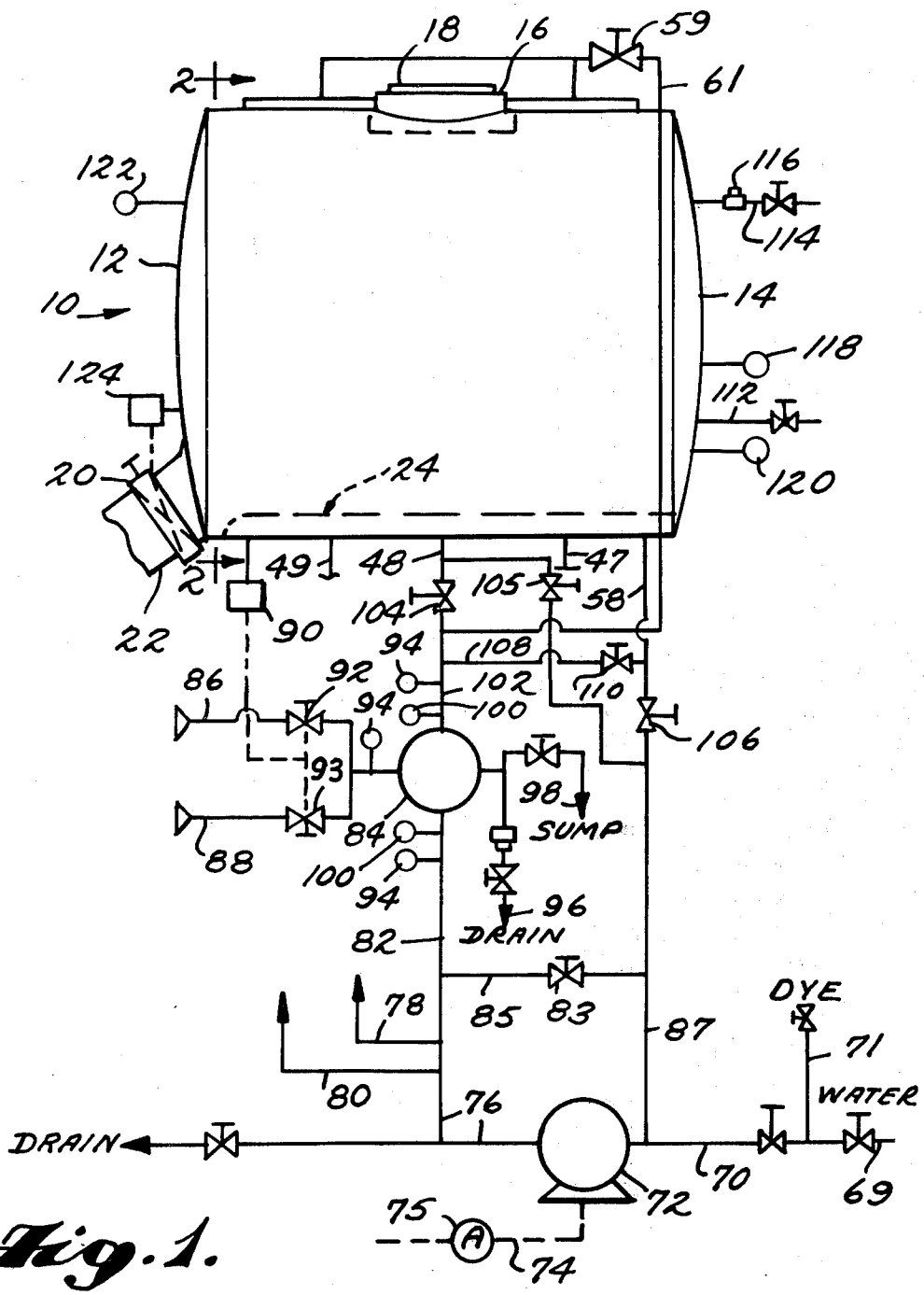

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Fig. 1.

Fig. 2.

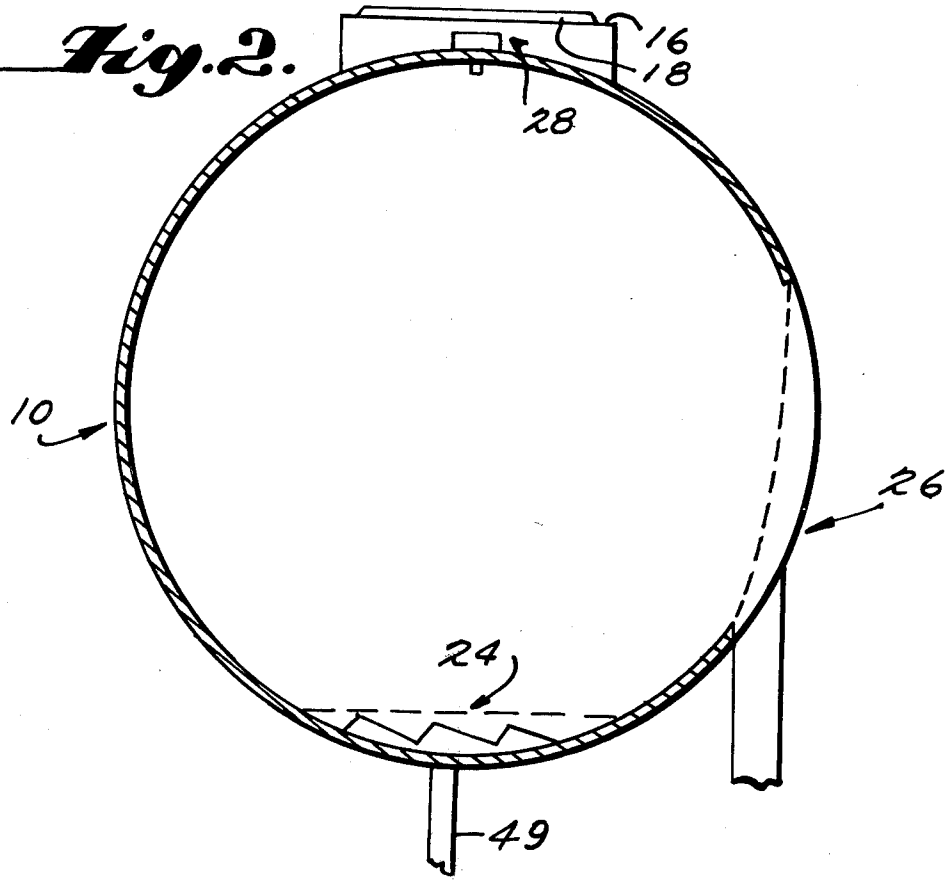


Fig. 4.

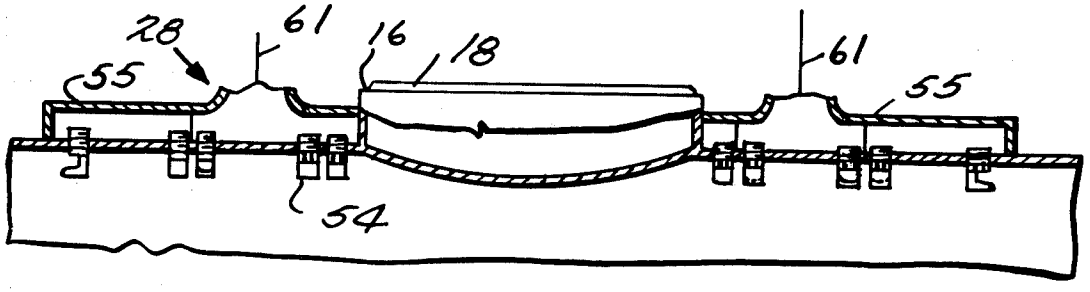


Fig. 3.

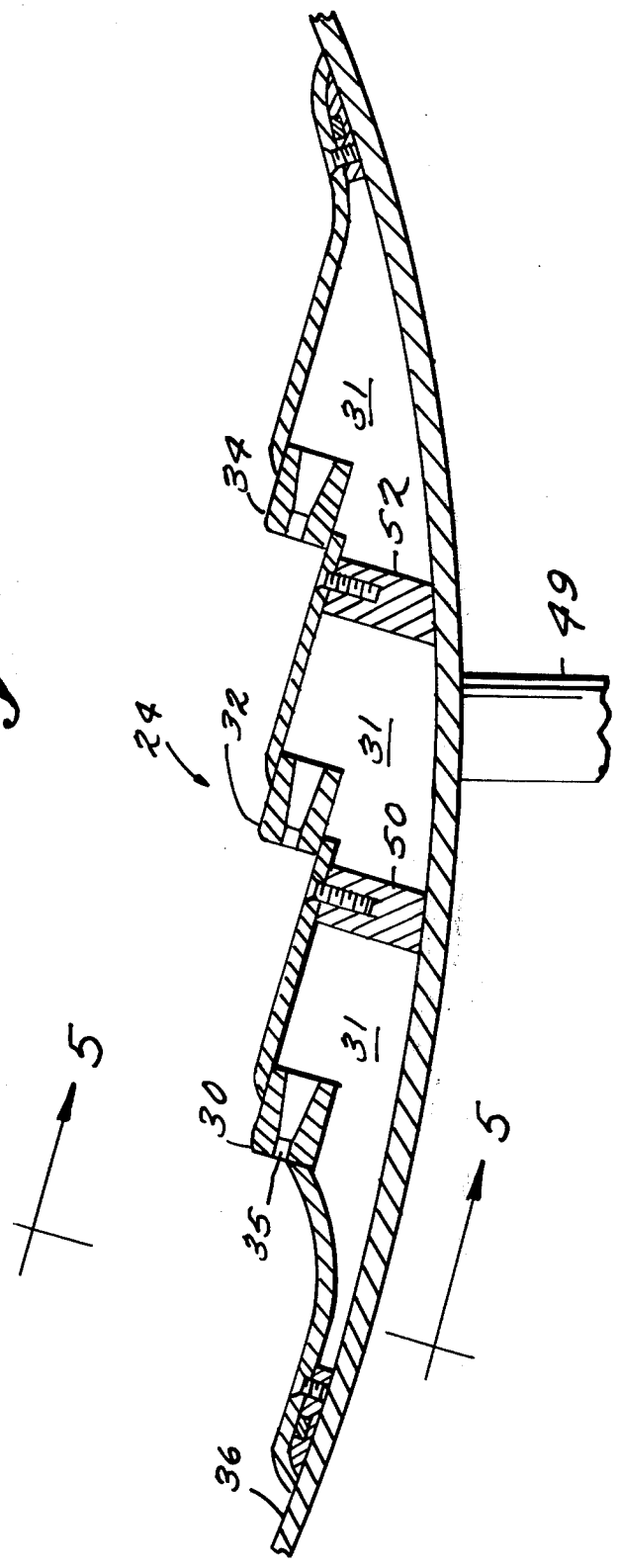


Fig. 5.

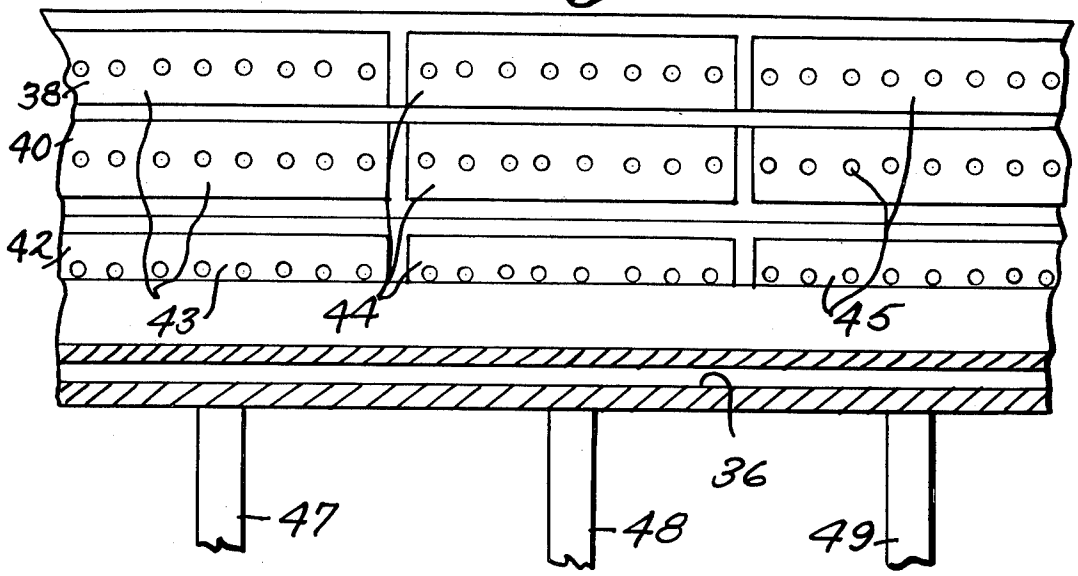
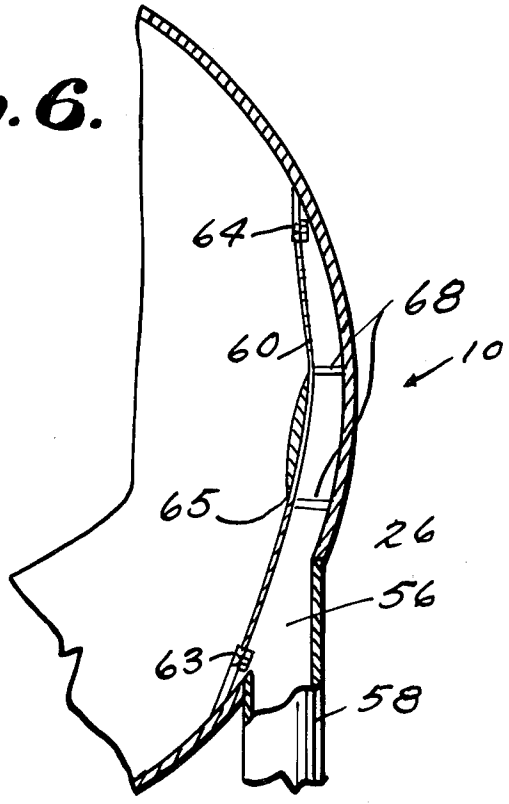


Fig. 6.



METHOD FOR DYEING TEXTILES

This is a division, of application Ser. No. 237,683 filed Mar. 24, 1972, and now U.S. Pat. No. 3,785,180.

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to the article dyeing field and, more specifically, to a novel dye vessel apparatus capable of achieving uniform dyeing of a plurality of discrete articles such as woven or knitted textiles, or the like, by providing means for controlling the fluid circulation and dye contacting pattern in the vessel with respect to the articles to be dyed as well as method of dyeing articles using the apparatus of the invention.

In the textile dyeing art, it has long been recognized that proper mixing of the dye liquor and objects being dyed was of significant, if not critical, importance in producing goods of precisely the same shade of color in a single dye batch. In attempting to achieve proper mixing, it has been the conventional practice to employ rotary paddles mounted in large vats or containers which are driven during the dyeing process to effect agitation of the articles and mixing of the dye liquor. These so-called paddle dye vessels have not proved satisfactory, however, chiefly by virtue of their lack of flexibility in terms of both the quantity and quality of the types of articles that could be treated in them. For example, delicate fabrics tended to suffer from abrasion as a result of contact with the paddles so that the speed of rotation of the paddles would have to be reduced resulting in an undesirable extension of the time required to properly dye the fabrics. In addition, the bearing mounts and seals required for the rotary paddles frequently presented maintenance problems particularly where it has been necessary or desirable to carry out the dyeing process under pressure.

In eliminating the use of paddles, efforts have been directed to obtaining suitable fluid circulation by the use of means for delivering a fluid under pressure to the interior of the dye vessel such as, for example, the arrangements disclosed in the U.S. Pat. Nos. to Clement et al., 3,091,109, to Casse, 3,199,752, to Peglar, 1,874,798 and the Newcomb, 2,707,382 which is assigned to the same assignee as the present invention.

Although various designs and assemblies such as those presented in the foregoing patents have been suggested in the past, none have proved to be sufficiently adaptable so as to be capable of solving the special problems encountered in commercial dyeing environments where production efficiency and precise quality control factors are of primary importance. Many of the prior art proposals have lacked means for compensating for the particular fabric characteristics so that their use has been limited often to a single type of fabric. Others have only been capable of accommodating a predetermined load size which can result in undesirable increases in production costs. Moreover, where it has been necessary to vary the quantity of items to be dyed, the color quality has either been adversely affected in terms of shade uniformity or permanence of the dyes.

The improvements of the present invention provide useful solutions to a number of significant problems recognized in the prior art as well as advantages which will enhance the production efficiency of discrete article dyeing processes.

In a preferred embodiment of the present invention, a cylindrical dye vessel is positioned with its longitudinal axis parallel to the horizontal. On the top side of the vessel, an article receiving port is provided which is of a size to facilitate loading of the vessel with discrete articles to be dyed. The port is provided with a closure member capable of withstanding the high pressures that occur during the dyeing process. On the bottom interior wall of the vessel opposite the loading port, a plurality of nozzles are positioned extending in generally parallel relationship with the longitudinal axis of the vessel. The outlets of the nozzles are positioned so as to direct fluid discharge therefrom in a generally tangential direction with respect to the interior wall of the vessel so that the liquid circulation in the vessel will be generally circular about an axis that is approximately parallel to or coincident with the longitudinal axis of the vessel. If desired, all of the nozzles may be supplied with liquid through a single conduit which is connected to the output of a high capacity pump through flow control means. Alternatively, for large capacity vessels the array of nozzles may be divided into a predetermined number of groups which extend end to end from one end of the vessel to the other. Each group of nozzles can then be connected to a separate pump or fed by a single pump through separate conduits each of which is provided with flow control means. For this latter arrangement means are provided for operating the individual flow control means so that the fluid circulation in the vessel can be regulated relative to the size of the load in the vessel as well as the mixing of the dye liquor. In both arrangements, means are provided for controlling the temperature of the fluid delivered to the nozzles whereby temperature variations of the fluid circulating in the vessel can be maintained at a minimum or, when desired, so that variations in temperature can be achieved uniformly throughout the vessel when necessary.

By employing a fluid delivery arrangement wherein the discharge of fluid into the vessel is distributed along the entire axis of the vessel, mixing of the dye liquor and control of temperature variations can be attained much more precisely and rapidly than has heretofore been possible.

Another feature of the present invention resides in the provision of a distributed fluid suction outlet which consists of a tangentially disposed slot provided in the wall of the vessel on the side of the nozzles opposite the direction of fluid discharge therefrom. Suction is applied to the suction outlet slot through a fluid conduit or conduits connected to the inlet of the pump or pumps which are provided for the nozzles. The area of this slot is preferably large so that the component of velocity of the circulating dye liquor into the slot will be small as compared to the tangential velocity component induced by the discharge from the nozzles so that the slot will be continually swept clean by the larger tangential velocity component. Also, with this arrangement, the quantity of fluid circulating in the vessel can be precisely controlled so that the concentration and mixing of the ingredients in the dye bath can be varied to accommodate different sized loads in the dye vessel.

Another feature of the present invention resides in the provision of an unloading valve capable of being operated by remote control so as to enable precise termination of the dyeing process by quickly emptying the dye vessel. The unloading of dye vessels for subsequent processing of the dyed articles and use of the dye vessel for a subsequent group of articles has previously been

a laborious operation. The unloading valve together with the provision of nozzles to flush out the vessel by cascading liquid over the interior of the vessel to assure the discharge of all of the discrete articles will greatly simplify this step in a discrete article dyeing process.

The article dyeing apparatus of the present invention will permit excellent control of the fluid circulation as well as mixing of the dye liquor in the vessel. In addition, variations in the load size can be compensated for so as not to adversely affect the quality of the dyed article either in terms of its fabric structure or color. The foregoing and other features and advantages of the present invention will become apparent in the more detailed discussion which follows below, and in that discussion, reference will be made to the accompanying drawing as described below.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a view in elevation of the dye vessel of the present invention illustrating in schematic form the fluid delivery system and temperature control means for one of the groups or nozzles;

FIG. **2** is a sectional view taken along lines **2—2** of FIG. **1** illustrating the disposition of the fluid delivery nozzles, suction outlet and rinse header;

FIG. **3** is a detailed sectional view looking down the longitudinal axis of the vessel showing the disposition of the nozzles with respect to the interior wall of the vessel;

FIG. **4** is a detailed view of the rinse header;

FIG. **5** is a view taken along lines **5—5** of FIG. **3** of the bank of nozzles of the present invention; and

FIG. **6** is a sectional detailed view parallel to the longitudinal axis of the vessel of the fluid suction outlet of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings wherein like numerals designate corresponding parts throughout the several views, there is shown in FIG. **1** the dye vessel **10** of the present invention. Preferably, the vessel is constructed from stainless steel and is capable of withstanding pressures on the order of 65 psi and temperatures about 300°F. The vessel **10** may be provided with suitable support legs (not shown) so that sufficient space will be available between the floor and bottom of the vessel **10** to accommodate the various plumbing and control elements. In the preferred embodiment, the vessel **10** is substantially cylindrical in cross-section and is provided with dished-ends **12** and **14.** The longitudinal axis of the vessel should extend in a horizontal plane. In the top central portion of the vessel, a generally circular loading port **16** is provided through which articles to be dyed can be delivered to the interior of the vessel **10** and through which the fluid discharge header **24** or fluid suction outlet cover **60** can be removed as will be described more fully hereinafter. A suitable closure member **18** is provided for the port **16** and may include a window to permit inspection of the interior of the vessel during the dyeing process. Closure member **18,** of course, must be designed to be able to withstand the high pressures which occur during the dyeing process.

A relatively large air actuated dump valve **20** is located in a conduit **22** which extends downwardly and away from the dished end **12** and serves as the unloading port for the vessel **10.** Conduit **22,** of course, will unload both the dye liquor and the dyed articles from the interior of the vessel into a suitable extractor where the dyed articles are separated from the dye liquor.

In FIG. **2,** there is shown an end view taken along lines of **2—2** of FIG. **1** looking down the longitudinal axis the vessel **10** and showing the relative locations of the fluid discharge header **24,** the suction outlet **26** and rinse header **28.** As will be described later in more detail, the discharge header **24** extends generally parallel to the longitudinal axis of the vessel **10** from adjacent the dished-end **12** to the other end **14** and is provided with an array of nozzles arranged to discharge fluid generally tangentially with respect to the interior wall of the vessel. The suction outlet **26** is located on the side of discharge header **24** opposite the direction in which the fluid is injected into the vessel.

In the enlarged sectional detailed view of FIG. **3,** where is shown the relative disposition of nozzles **30,** 32 and **34** with respect to each other and the bottom portion **36** of the vessel **10.** Each of the nozzles is directed so as to discharge fluid through openings, one of which is indicated at **35** in a tangential direction with respect to the interior surface of the vessel so that the fluid flow in the vessel **10** will be generally circular about the longitudinal axis of the vessel.

As can be seen in FIG. **5,** the fluid discharge header **24** consists of three rows of nozzles, designated at **38,** 40, and **42** which, as pointed out above, extend along the bottom portion of the cylinder **10** in generally parallel relation with the longitudinal axis of the vessel **10.** It should be understood that while three rows of nozzles are illustrated as few as one or more than one can be used. In one embodiment, the three rows of nozzles are divided into groups such as those designated by the numerals **43, 44** and **45.** The nozzles of an individual group are supplied with fluid under pressure by a separate conduit such as the conduit **47** for group **43,** the conduit **48** for group **44** and conduit **49** for group **45.** As shown in FIG. **3,** conduit **49,** as are conduits **47** and **48,** is cnnected to its group of nozzles through the bottom portion of vessel **10.** It is preferable that the delivery capacity of the respective conduits **47, 48** and **49** be large enough to assure that each of the nozzles of each group are supplied with fluid at as nearly the same pressure as possible. The support studs **50** and **52** are distributed along the bottom of the vessel **10** and serve to impart rigidity to the discharge header structure and the groups of nozzles are separated by walls such as at **31** in FIG. **3.**

If desired, as previously noted, all of the nozzles may be supplied with fluid from a single conduit which is connected to a single high capacity output pump.

Referring to FIG. **4,** the rinse header **28** consists of a plurality of nozzles one of which is indicated at **54** which are arranged to spray a rinsing liquid over the interior surfaces of the vessel **10** subsequent to the completion of the dyeing process. The rinse header **28** is utilized when the unloading valve **20** is open to flush out the interior of the dye vessel and carry out and complete the removal of any remaining articles. The nozzles **54** are attached to a member **55** which extends along the top of the vessel on either side of the loading port **16** and is secured to the top portion of the vessel **10.** The rinsing liquid may be supplied to the rinse header **28** by conduit **61** which is fitted through the walls of the member **55.** Valve **59** is used to control the fluid delivery through conduit **61.**

Turning now to FIG. 6, there is shown a detailed view of the fluid suction outlet 26 which consists of a generally rectangular slot 56 which extends along the wall of the vessel 10 from one end thereof to the other and is connected to conduit 58 which is in fluid communication with the inlet side of pumping means utilized to supply fluid to the fluid discharge header 24, later to be described. A perforated metal plate 60 which may be coated with a friction reducing substance such as that sold under trademark "TEFLON," is mounted within the vessel 10 and extends the length of a slot 56. The lower end of the plate 60 is fixed as at 63 adjacent to the lower edge of the slot 56 while the upper end of the plate 60 is secured to the inner wall of the vessel at 64 which is at a distance from the slot 56. With this arrangement of the perforated plate 60, the open area of the suction outlet 26 is increased so that the radial velocity and flow of liquid into a unit area of the slot 56 is small in comparison to the tangential velocity component of the circulating liquid. The tangential circulation which is achieved as a result of the tangential discharge from the fluid discharge header 24 will keep the suction entrance free of articles being dyed while the liquid level in the dye vessel 10 can be controlled by the suction existing in conduit 58. A Teflon coated-convexly curved blank 65 may be positioned as illustrated in FIG. 6 across the plate 60 to facilitate the movement of articles past the plate 60 by breaking the suction pull through the screen. Spacers 68 may be provided to maintain the position of the plate 60 and blank 65 with respect to the wall of the vessel.

The operation of a dyeing apparatus as thus far set forth will now be described with reference in particular to FIG. 1 however, it should be understood that the following description is merely one example of the manner in which the apparatus of the present invention may be operated and that numerous variations will be apparent to those skilled in this art.

Liquid is supplied through valved conduit 70 to the inlet side of a high capacity pump 72 which may be of the open impeller type. Dye material is added through valved conduit 71 or, if desired, directly through port 16. The driving motor of pump 72 is preferably electric and current to the motor is monitored by ammeter 75 in line 74. The output of pump 72 is fed through conduit 76 to one or more fluid control systems, one being provided for each of the groups of nozzles in the discharge header 24 when separated groups are used. Since each of these fluid control systems are identical, only the system which supplied fluid to the conduit 48 will be described, it being understood that the conduits 78 and 80 will direct fluid to similar control system for conduits 47 and 49 respectively if such separated groups of nozzles are used. Conduit 82 will deliver liquid to a heat exchanger 84 and a bypass valve 83 in conduit 85 is used to control the volume and velocity of the liquid supplied to the conduit 82. The heat exchanger 84 is of conventional design and may consist simply of a chamber in which a plurality of tubes are arranged which carry fluid from conduit 82. Steam may be fed through conduit 86 and chilled water may be fed through conduit 88 in amounts regulated by a temperature programmer 90 which controls throttle valves 92 and 93 so that the amount of heat transferred to the liquid passing through the heat exchanger 84 may be precisely proportioned. Conventional temperature indicating means such as thermocouples 94 are appropriately connected to the conduits leading into and out of the heat exchanger 84 so that the temperature condition of the respective fluids can be monitored. The steam or chilled water is delivered from the heat exchanger 84 either to a drain through conduit 96 which is provided with a gate valve and steam trap or to a sump through conduit 98 which is also provided with a conventional gate valve. Pressure indicating gauges 100 may also be supplied in conduit 82 and 102 to permit monitoring and accurate control of the fluid delivered to the fluid discharge header 24. Conduit 102 is connected to conduit 48 through an air actuated gate valve 104.

As previously described, conduit 58 will pass fluid from the vessel 10 through an air actuated gate valve 106 to the suction inlet of pump 72. A valved bypass conduit 108 is provided between conduits 102 and 58 so that fluid delivered by the pump 72 may be used to backwash perforated plate 60. This is achieved by closing valve 104 and 106 and opening valves 105 and 110. With pump 72 running in the normal manner fluid will be taken from the header 24 and passed from the pump 72 to line 108 to discharge through the suction outlet 26. This reverse circulation will effectively clean perforated plate 60 of lint or other material that may accumulate thereon during a dye cycle.

The dye vessel 10 is provided with a water supply through valved conduit 112 as well as valved conduit 69 and air under pressure through valved conduit 114 which is also provided with a pressure regulator 116. An appropriate number of condition monitoring means such as pressure indicators 118 and temperature indicators 120 may be provided at spaced points about the vessel 10. A conventional liquid level indicator 122 should be provided as is customary in dyeing apparatus. The dump valve 20, as a safety precaution, should be provided with a temperature interlock 124 so that the valve will not open in the event that the fluid in the dye vessel 10 is in excess of a predetermined temperature. The dye vessel 10 should also be provided with a closable air vent and adjustable pressure relief valve while the closure member 18 in port 16 should be provided with a pressure interlock so that the port will not open where there is more than a predetermined pressure difference between the inside of the vessel 10 and the prevailing atmospheric pressure.

After the dye vessel is loaded with articles such as socks to be dyed through the top port, water at the appropriate temperature is supplied through valve conduits 69 and 70, through the pump, heat exchanger and valve 104 to all of the nozzles or to a selected group of nozzles depending upon the type of arrangement employed. The temperature of the water may be regulated as it passes through the heat exchanger 84. Subsequently, dye is added through conduit 71, 70 and 76 and 82 to the heat exchanger 84 and is mixed with the water already in the vessel 10. The temperature of the liquid in the vessel is then raised to a predetermined level by circulating the liquid through the heat exchanger 84 which is appropriately modulated. An air pad is then applied to the vessel through conduit 114 so that the pressure dyeing temperatures are achieved. As previously noted bypass valve 83 is used to adjust the volume and velocity of the fluid delivered to the vessel with suction being transmitted through conduit 87 which is connected to the suction inlet of pump 72.

When dye has been exhausted, the vessel 10 is cooled so that it can be unloaded. This is accomplished by ap-

plying cold water to heat exchanger **84** or by introducing additional cool water through valved conduit **69** while discharging excess water to drain. Before unloading the vessel **10**, it may be desirable to add a treatment solution such as a softener which can be simply achieved by addition of the desired material upstream of the pump **72**. Subsequently it is preferable to backwash the fluid which is accomplished by operating the valves as indicated above. To unload the vessel **10**, the air pad is maintained through conduit **114** and pressure regulator **116** and valve **20** is open. When the liquid level in the machine reaches a predetermined point, the air pad is turned off and valve **59** is opened to admit fluid to the rinse header **28**. In addition, water is admitted through conduit **112** at this time and this conduit is arranged to directly flow at a large velocity in the direction of the unloading valve **20** to assure removal of all articles from the vessel. The nozzles **54** of the rinse header are arranged so as to cascade water down all the internal surfaces of the dye vessel **10** to wash out any remaining articles from the vessel **10**.

To facilitate efficient operation, all of the valves of this system should be of the remotely controllable, air actuated type so that all of the valves as well as the pump and the monitoring control elements can be centrally mounted and displayed on a control console and sequentially actuated by a rotary switch arrangement, by card or tape readers, or a timed stepping switch system. When using a control arrangement such as one of the foregoing, a number of operating conditions would be pre-set, such as the rate of temperature rise, the flow rate, the liquid level and the air pad pressure, all depending on the quantity of articles to be dyed in a given cycle of the apparatus. As pointed out previously, where inspection or monitoring indicates non-uniform turbulence within the dye vessel **10**, the flow of liquid to an individual group of nozzles can be throttled back by adjusting the valves effecting the delivery of fluid to the respective group of nozzles. Similarly, where the monitor elements indicate temperature variations in the nature of cold or hot spots in the die vessel **10**, the temperature of the fluid discharged from the appropriate group of nozzles can be adjusted to compensate for the variation.

One of the principal advantages of the apparatus of the present invention resides in its ability to handle variable quantities of discrete articles in a dye cycle due chiefly to the design of the fluid suction outlet **26** since by virtue of its large open area along the circumference and length of the dye vessel **10** suitable fluid mixing and circulation can be maintained commensurate with continuous variations in load sized as opposed to discrete differences. By way of example, with a dye vessel having dimensions of approximately 5 ½ feet in length and 5 feet in diameter and with the capacity of conduits **47**, **48** and **49** equaling approximately the capacity of conduit **58**, the dye vessel **10** could be used for loads ranging from 50 to 200 pounds corresponding to approximately 190 to 750 gallons of dye, respectively.

From the foregoing, it can be appreciated that the apparatus of the present invention provides a very efficient and versatile device that is capable of achieving and controlling optimum operating conditions which is particularly important in the dyeing of numerous synthetic materials that are now being used in the manufacture of clothing articles.

Although the invention has been described with reference to a particular embodiment, it will be understood that variations in the described embodiment will become obvious to those skilled in this art. Also certain modifications or additions can be made to the described structure and all obvious variations and modifications are intended to be included in the scope of this invention.

What is claimed is:

1. A method of uniformly dyeing a plurality of discrete textile articles in a dye vessel of the type having a substantially cylindrically shaped interior wall with a horizontally disposed longitudinal axis and spaced apart end walls, at least one row of nozzles arranged to discharge liquid in a generally tangential direction with respect to said interior wall, a closable loading port and closable unloading port, conduit means for supplying liquid to said row of nozzles, means for controlling the temperature of the liquid supplied to said row of nozzles, including means for circulating said liquid through adjustable heat transfer means, means for controlling the rate of flow of the liquid through said conduit means, the method comprising the steps of:

supplying a liquid under pressure through said row of nozzles to the interior of said vessel to set up a substantially circular flow about said longitudinal axis of the liquid and articles to be dyed,

heating said liquid to a first predetermined temperature,

supplying a dye material through said row of nozzles while maintaining the circular flow of the contents of said vessel,

heating the contents of said dye vessel to a second predetermined temperature that is higher than said first temperature by passing the liquid contents of said vessel through said heat transfer means,

maintaining the circular flow in said vessel until the dye material is exhausted,

cooling the contents of said vessel to a predetermined temperature by passing the liquid contents of said vessel through said heat transfer means, and subsequently

unloading the articles and liquid in said vessel through said unloading port.

2. The method as claimed in claim **1** wherein a liquid outlet is provided adjacent said row of nozzles in said wall of said vessel and including the step of reversing the direction of liquid flow in said vessel, subsequent to the cooling step, by supplying liquid to the interior of said vessel through said outlet.

3. The method as claimed in claim **1** including the step of placing the contents of said vessel under a predetermined pressure subsequent to the step of supplying a dye material thereto.

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