

[54] **APPARATUS FOR LIQUID TREATMENT OF TEXTILE MATERIAL WEBS**

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[52] U.S. Cl. ....68/177, 68/184, 68/207

[51] Int. Cl. ....B05c 3/134

[58] Field of Search.....68/207, 177, 184

[56] **References Cited**

**UNITED STATES PATENTS**

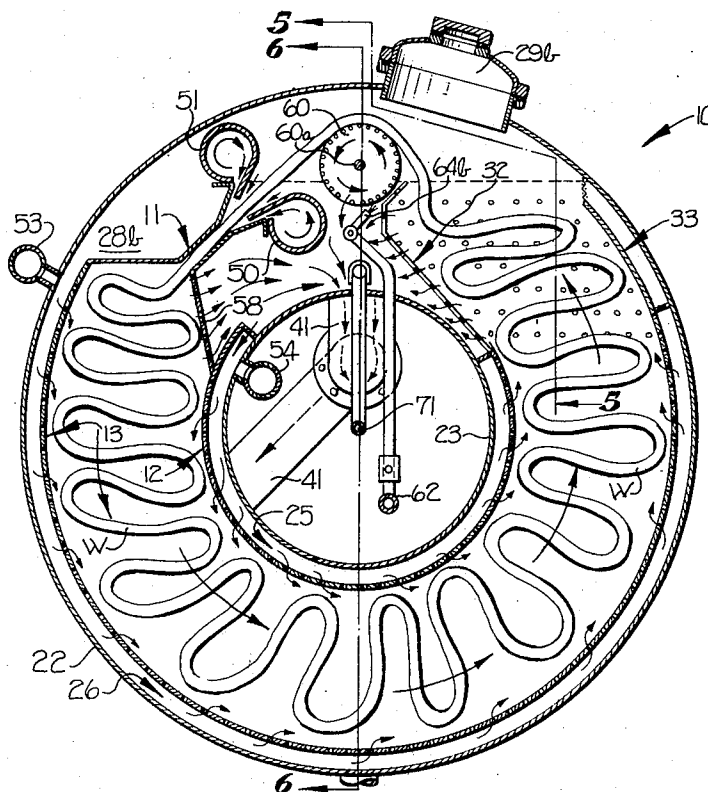
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Primary Examiner—William I. Price  
Attorney—Parrott, Bell, Seltzer, Park & Gibson

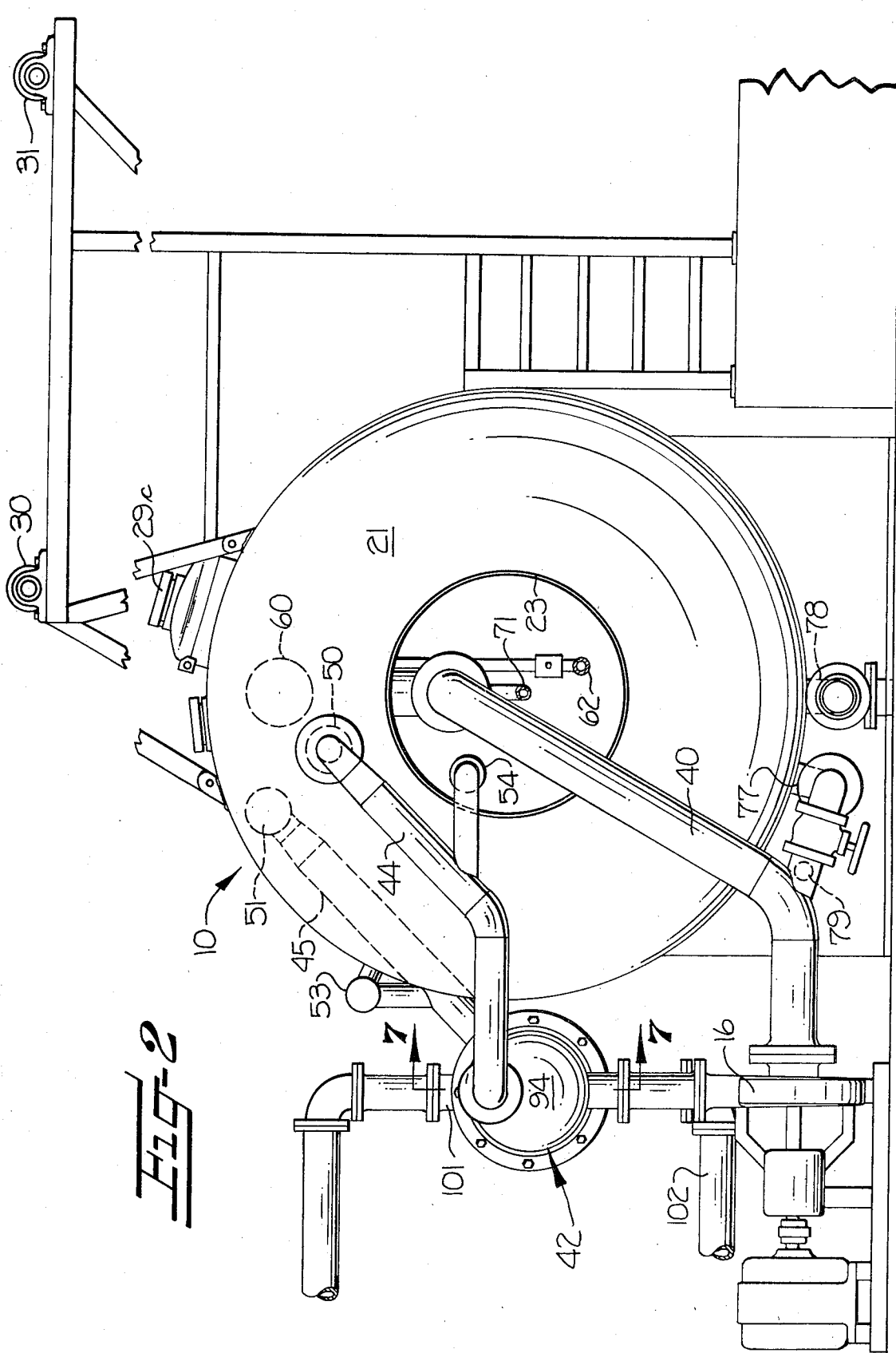
[57] **ABSTRACT**

Textile material webs are subjected to liquid treatment while in open width form by an apparatus and method in which a length of textile web to be treated is arranged in an open width loop and is moved within a generally annular chamber by direction of portions of a circulating liquid flow through a throat zone for entraining the textile web. Treatment liquid is impinged against both surfaces of the textile web by direction of portions of the circulating liquid flow through spaced arcuate inner and outer walls which define a treatment zone adjacent to and of a greater cross-sectional area than the throat zone. Agitated contact of treatment liquid with the textile web material occurs throughout both the throat and treatment zones and thorough treatment of the textile web is thereby facilitated. Further, distribution of the portions of the circulating liquid flow assures uniformity of conditions throughout the throat and treatment zones.

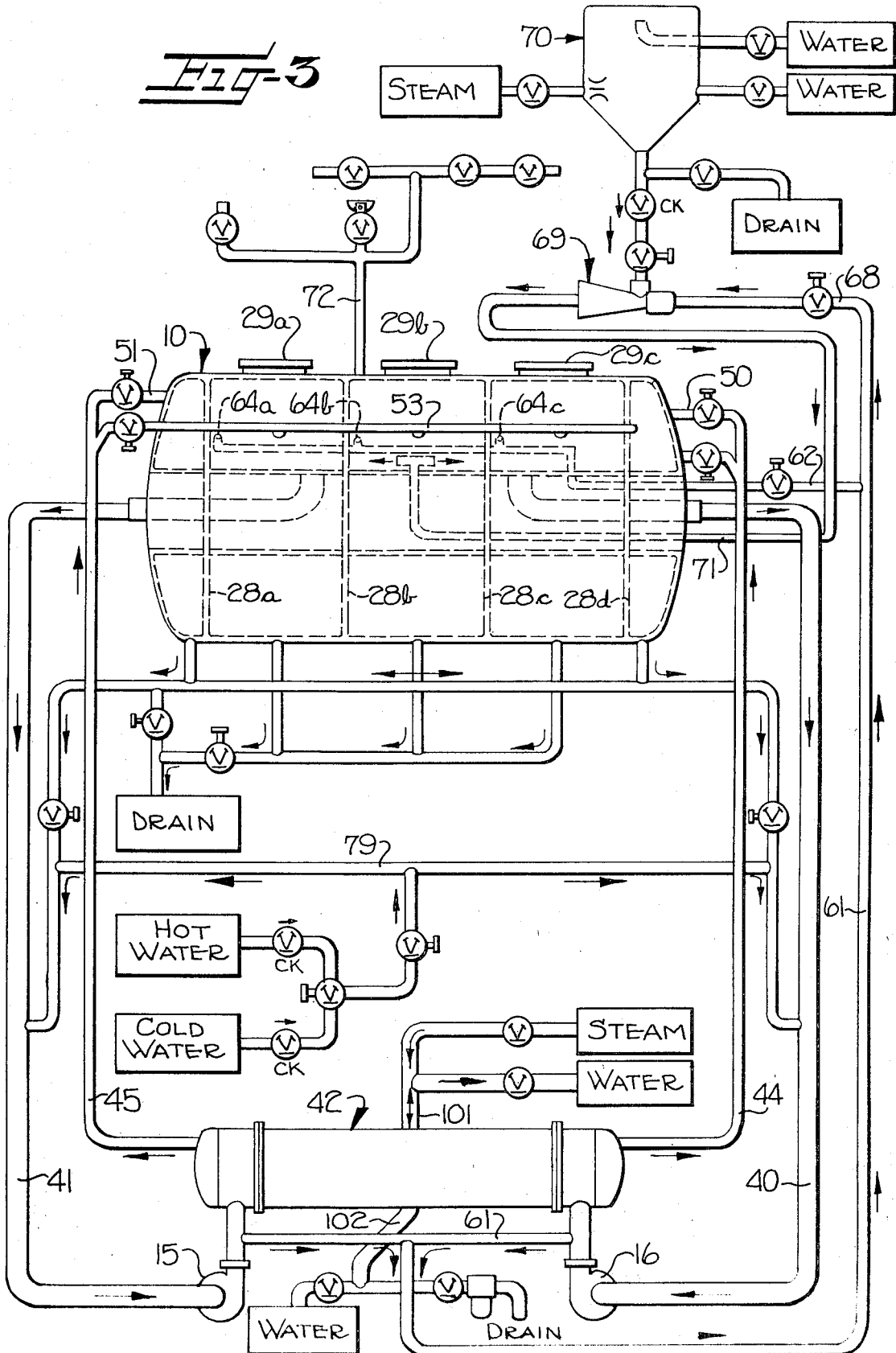
13 Claims, 10 Drawing Figures

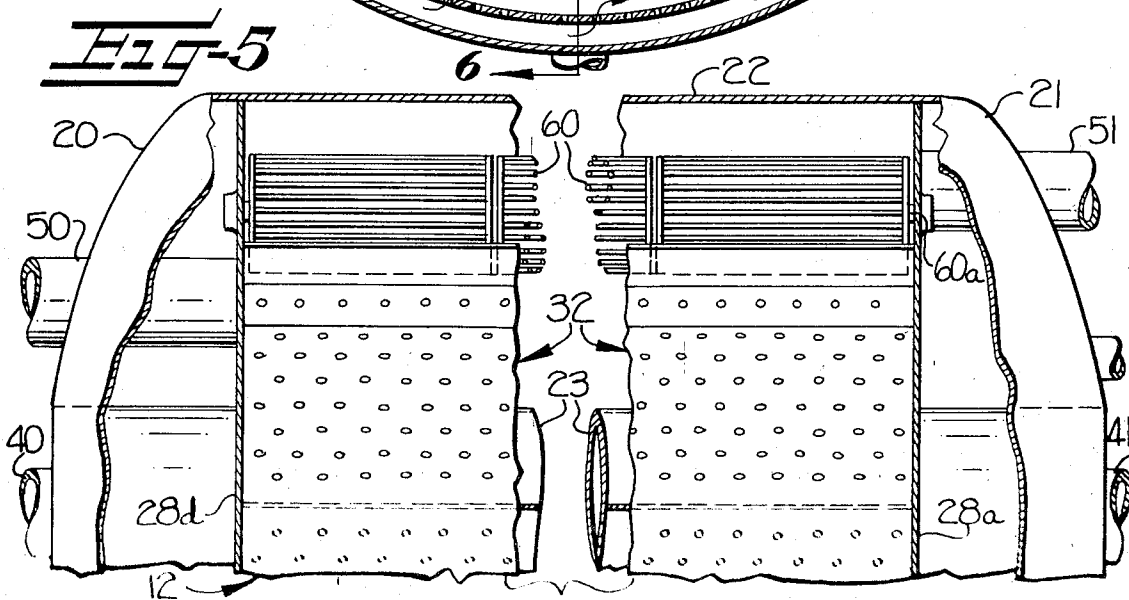
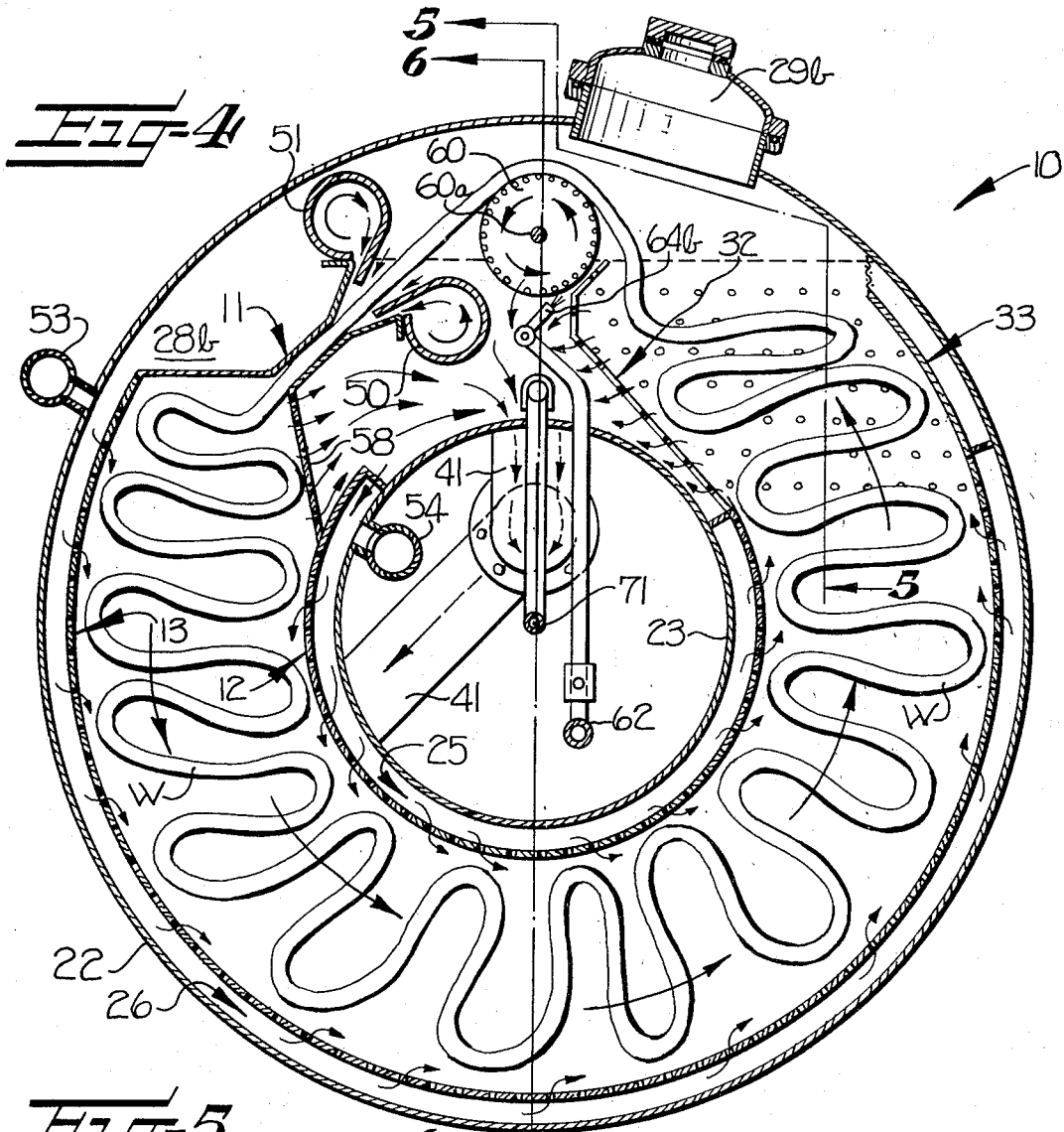


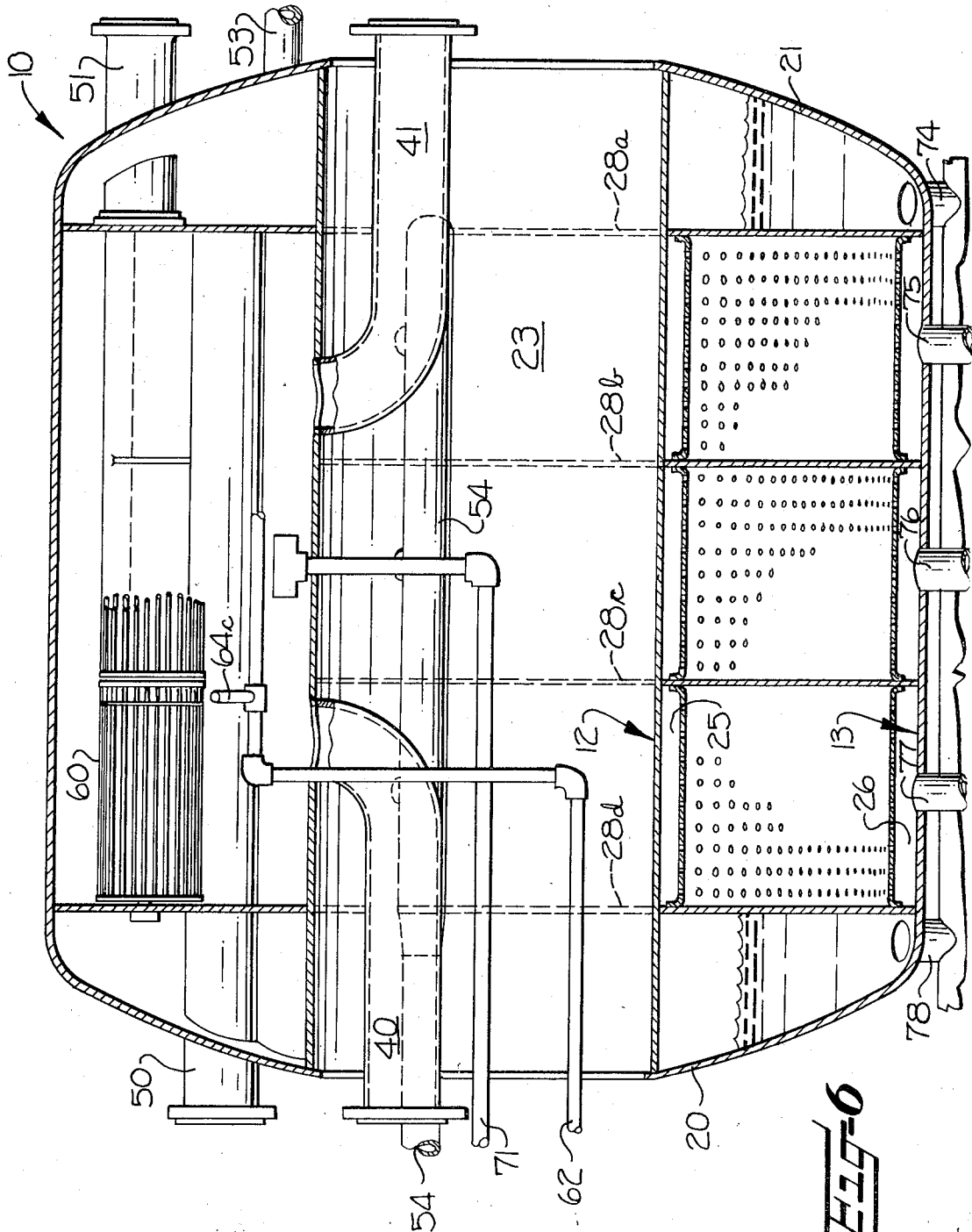




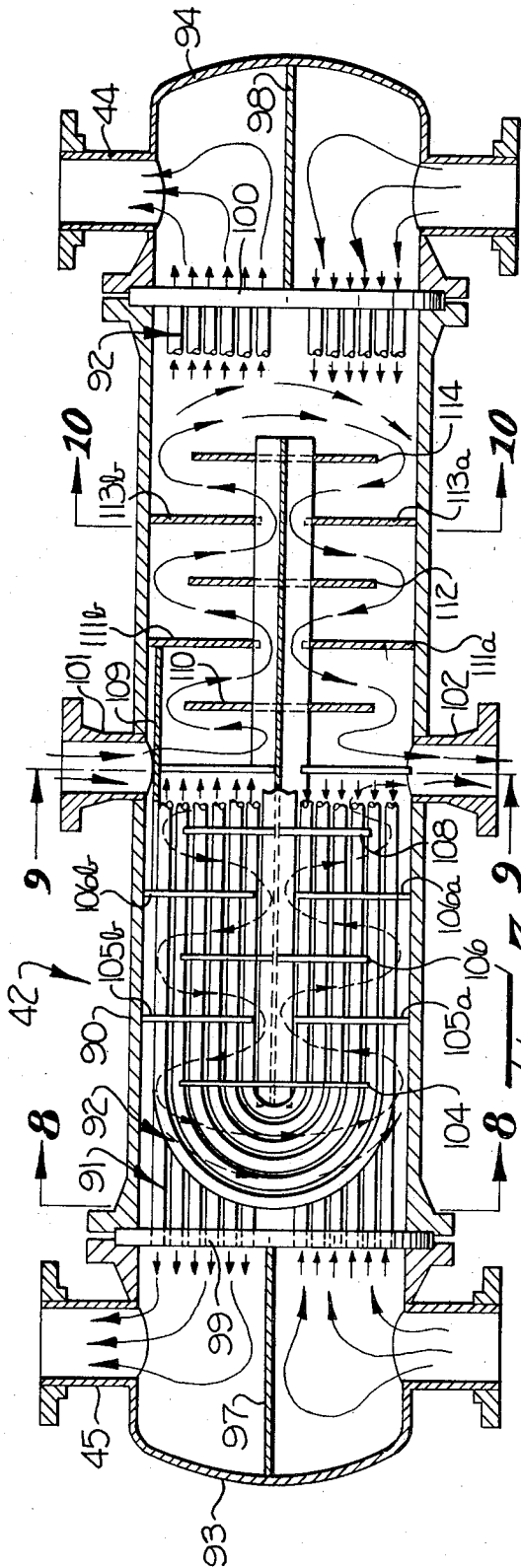
**FIG-3**



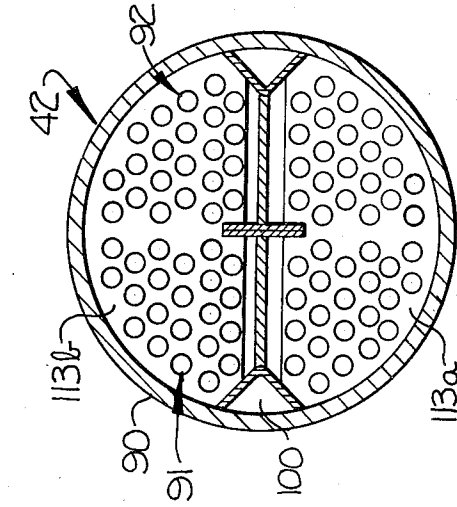




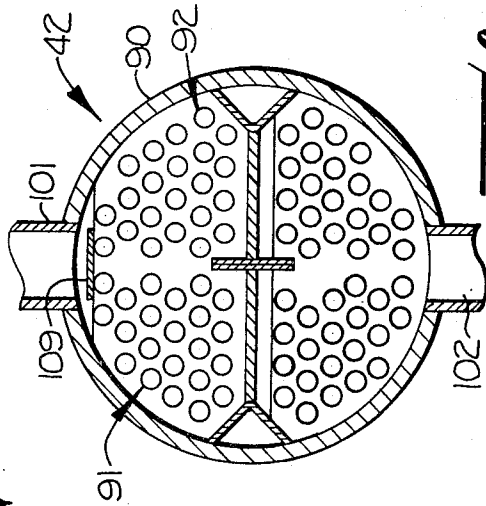
**Fig-6**



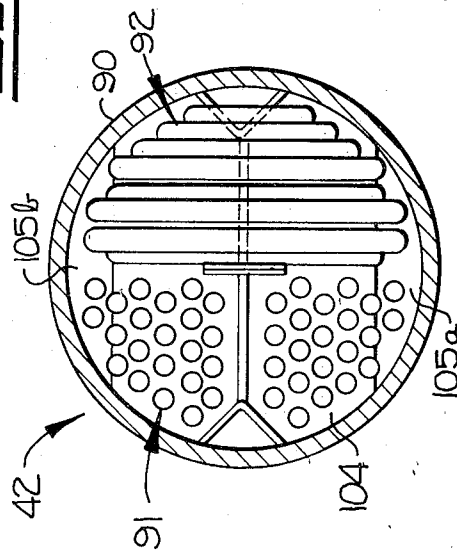
**FIG-7**



**FIG-10**



**FIG-9**



**FIG-8**

## APPARATUS FOR LIQUID TREATMENT OF TEXTILE MATERIAL WEBS

Batch processing of lengths of textile web materials such as knitted fabrics has heretofore been accomplished by apparatus and methods in which a length of material is sewn into a loop extending within a generally annular passageway and is moved within the passageway while being subjected to treatment by appropriate liquids such as dye solutions. While such apparatus and methods are presently in use and have been relatively well accepted for finishing of textile materials, certain difficulties and deficiencies are encountered in commercial applications.

A major difficulty arises in obtaining uniform treatment throughout the length of textile web subjected to liquid treatment in accordance with prior practices. It is not uncommon, in commercial applications of prior apparatus and methods, for a length of textile web material to have noticeable non-uniformities after being subjected to liquid treatment of the type briefly described above. It is believed that this difficulty flows in large part from two characteristics of prior apparatus and methods, namely the use of circular throats or jets to induce movement of the loop of textile web and reliance upon agitated contact of treatment liquid with the textile web in the throat only. In prior apparatus, the loop of textile web to be treated is moved within an annular chamber by direction of circulating liquid flow into a throat which is circular in cross-section. The throat, acting as an eductor, forms the textile web material into a rope-like configuration and entrains the roped web in movement within the annular chamber.

As will be readily understood, the widthwise folding necessary to reduce the textile web to rope-like form tends to shield portions of the web from full contact with treatment liquid. Further, the action of the jet for eduction flow within the circular throat tends to compound such widthwise folding by increased entangling and twisting of the textile web.

Other difficulties encountered with prior liquid treating apparatus and methods for textile webs, of the general type described briefly hereinabove, have resulted from piling of the roped textile web within the apparatus with results in the non-uniform exposure of the material to the treatment liquid and variations in treatment liquid characteristics such as temperature and concentration which similarly result in non-uniform treatment. Efforts at resolution of these difficulties have typically involved attempts at controlling the circulation and flow of a treatment liquid within an apparatus, with multiple adjustable controls being employed. With such multiple variables at hand for an operator, incorrect adjustment is not uncommon, bringing about less than optimal performance of the apparatus and further compounding the inherent difficulties briefly described above. Further, even when adjusted for optimal operation, such prior apparatus has not successfully maintained substantially uniform treatment liquid conditions throughout the apparatus.

It is an object of the present invention to facilitate thorough treatment of a length of textile material web with a treatment liquid by accomplishing agitated contact between the surfaces of the textile web and a circulating flow of uniform characteristic treatment liquid. In accomplishing this object of the present invention, textile material web is treated by an apparatus and in

accordance with a method wherein the textile web is arranged in an open width loop to expose both surfaces of the textile web for contact with the treatment liquid. A circulating flow of treatment liquid is induced within a generally annular chamber containing the looped textile web, with portions of the circulating liquid flow being directed through a throat zone for entraining the textile web and other portions of the circulating liquid flow being directed into a treatment zone for impinging against the surfaces of the textile web. By such entraining and impingement, agitated contact of treatment liquid with the entirety of the textile web occurs throughout a substantial portion of the apparatus. Further, mixing of the circulating flow and direction thereof to the throat and treatment zones promotes uniformity of treatment conditions throughout the apparatus.

A further object of the present invention is the liquid treating of a textile material web in open width form in accordance with a method wherein the maintenance of uniform treatment conditions throughout a chamber containing a looped open width length of textile web to be treated is promoted by the distribution of recirculated liquid delivered into the chamber across the width of the textile web. In accordance with this object of the present invention, a circulating flow of treatment liquid through the chamber is achieved by withdrawing liquid from the chamber at least one predetermined location, recirculating the withdrawn liquid back into the chamber and distributing the recirculated liquid widthwise of the textile web. Such withdrawal from at least one fixed location and widthwise redistribution avoids the possibility of stratification of flow, thereby promoting more uniform treatment of the textile web.

Yet another object of the present invention is the treatment of textile material web in an apparatus which maintains the web in a loosely floating or fluidized state throughout a substantial portion of its length. In realizing this object of the present invention, a portion of a circulating flow of treatment liquid is directed into a treatment zone through spaced arcuate inner and outer walls, thereby impinging the liquid against both surfaces of a textile web passing through the treatment zone defined between the walls. Such impingement of treatment liquid against both surfaces of the textile web precludes such packing of folded textile web as would interfere with uniform treatment thereof.

Some of the objects and advantages of the invention having been stated, others will appear as the description proceeds, when taken in connection with the accompanying drawings, in which:

FIG. 1 is a rear elevation view of the apparatus of the present invention;

FIG. 2 is an end elevation view, taken from the right side of as viewed in FIG. 1, of the apparatus of the present invention;

FIG. 3 is a schematic piping diagram of the apparatus of FIGS. 1 and 2;

FIG. 4 is an elevation view, in section, of the apparatus of FIGS. 1 and 2, taken generally along the line 4-4 in FIG. 1;

FIG. 5 is a partial elevation view, in section, taken generally along the line 5-5 in FIG. 4;

FIG. 6 is a view somewhat similar to FIG. 5, taken generally along the line 6-6 in FIG. 4;

FIG. 7 is an enlarged elevation view, in section, of a heat exchanger included in the apparatus of the present invention, taken generally along the line 7—7 in FIG. 2;

FIG. 8 is a section view taken generally along the line 8—8 in FIG. 7;

FIG. 9 is a view similar to FIG. 8, taken generally along the line 9—9 in FIG. 7; and

FIG. 10 is a view similar to FIGS. 8 and 9, taken generally along the line 10—10 in FIG. 7.

In the more detailed disclosure which follows, the apparatus of the present invention will be described with particular reference to an illustrative embodiment as set forth in the accompanying drawings, while the method of the present invention will be made clear by the description of the operation of that illustrative embodiment. However, it is to be understood at the outset of the present disclosure that the drawings represent only an illustrative embodiment in that the objects and advantages of the present invention may be realized and obtained by structures and operations which may differ in detail from the following disclosure.

The illustrative embodiment of the apparatus in accordance with the present invention broadly comprises tank means generally indicated at 10 for containing the length of textile web W (FIG. 4) to be treated as arranged in an open width loop, with the tank means 10 enclosing a generally annular chamber (FIG. 4). Web guide means generally indicated at 11 are arranged within the tank means 10 for forming a throat zone of generally rectangular cross-sectional configuration, while spaced arcuate inner and outer wall means generally indicated at 12, 13 define a treatment zone adjacent to and of greater cross-sectional area than the throat zone. Treatment liquid circulating means, including first and second pumps 15, 16 and conduit means cooperating therewith as described more fully hereinafter, operatively communicate with the tank means 10 for circulating a flow of treatment liquid through the generally annular chamber. Portions of the circulating flow are directed through the throat zone defined by the web guide mean 11, for entraining textile web and thereby functioning as web moving means. Other portions of the circulating liquid flow are directed into the treatment zone through the inner and outer walls means 12, 13 for impingement of the liquid against both surfaces of the textile web W so as to function as web treating means.

In the illustrated embodiment, the tank means 10 includes an enclosing shell means having a generally stretched toroidal form as defined by annular end walls 20, 21, and outer cylindrical shell 22, and an inner cylindrical shell 23. The inner shell 23 cooperates with the arcuate inner wall means 12 for defining therebetween a fluid flow passageway 25 (FIG. 4). Similarly, the outer shell 22 cooperates with the arcuate outer wall means 13 for defining therebetween a fluid flow passageway 26 (FIG. 4).

In order to accommodate the simultaneous batch processing of a plurality of lengths of textile web, the apparatus of the present invention includes interior partition walls 28a, 28b, 28c and 28d (FIG. 3) subdividing the interior of the stretched toroidal tank means 10 into a plurality of parallel annular chambers (one of which is shown in cross-section in FIG. 4). The discussion which follows will proceed with particular

reference to one of these annular chambers, but it is to be noted that a plurality of chambers are served by common treatment liquid circulating means in such a manner that a common process is carried out in the plurality of chambers. While such a construction and operation is preferred in order to increase the quantity of textile material web subjected to liquid treatment, the present invention is equally applicable to an apparatus having only a single annular chamber.

In order to accommodate the introduction and removal of lengths of textile web to be treated, the tank means 10 is provided with suitable ports 29a, 29b, 29c opening into corresponding treatment chambers. Overhead guide rolls 30, 31 arranged on a suitable supporting framework (FIGS. 1 and 2) aid in such introduction and removal of lengths of textile material web.

During operation of the apparatus, a predetermined depth of treatment liquid is retained within an annular chamber through the operation of baffle means 32, 33 which cooperate with other elements of the apparatus for forming an expansion zone. More particularly, volumes between the end partitions 28a, 28d and the corresponding enclosures 20, 21 communicate with a volume adjacent the guide means 11 which defines the throat zone, for receiving in the expansion zone thus defined any excess of treatment liquid above that required for maintenance of the predetermined depth within the chamber. The upper most extremity of the baffle means 32, 33 thus functions as a weir over which excess liquid may flow. The height of liquid maintained is correlated to the positioning of the throat zone as pointed out more fully hereinafter, in order minimize foaming otherwise possibly resulting from direction of a portion of circulating liquid flow into the throat zone.

In the circulation of a flow of treatment liquid through a chamber, suction conduit means 40, 41 operatively communicate with the expansion zone within the tank means 10, for withdrawal of treatment liquid from the tank means 10 at two locations. The suction conduit means 40, 41 operatively communicate with corresponding ones of two pumps 15, 16, which induce the circulating flow of treatment liquid now to be described. The principle amount of treatment liquid withdrawn through the suction conduits 40, 41 by the pump 15, 16 is recirculated to the tank means 10 by passage through a heat exchanger generally indicated at 42 (and to be described more fully hereinafter with particular reference to FIGS. 7-10) and discharge conduits 44, 45. Each of the discharge conduits 44, 45 serves a corresponding distribution conduit arrangement which distributes the recirculating flow of treatment liquid widthwise of the annular chambers within the tank means 10, whereby treatment liquid withdrawn from one particular point within the expansion zone is distributed over a relatively wide area widthwise of textile web being treated, contributing to continuous mixing of the treatment liquid and the maintenance of more uniform conditions throughout the apparatus, as will be further described hereinafter.

Each of the discharge conduits 44, 45 branches to serve one of two throat zone supply conduits 50, 51 and one of two treatment zone distribution conduits 53, 54. By way of example, the discharge conduit 45 operatively communicating with the first pump 15 serves an outer throat zone distribution conduit 51 and an outer

treatment zone distribution conduit 53. The throat zone conduit 51 penetrates one end wall 21 of the tank means 10 to extend longitudinally within the tank means 10 and serve the plurality of annular chambers therewithin. Within each of the annular chambers, the throat zone distribution conduit 51 delivers a circulating flow of treatment liquid in a flat sheet or thin stream passing immediately adjacent the guide means 11, and through one side of the throat zone defined thereby (FIG. 4). It is to be noted that the point of discharge of liquid from the throat zone distribution conduit 51 into the throat zone is below the liquid-air interface of the quantity of liquid retained within the annular chamber, thereby avoiding entraining of air into the circulating treatment liquid.

Similarly, the treatment zone distribution conduit 53 spans the width of the tank means 10 and communicates with the outer liquid passageway 26 in each of the annular chambers. Liquid entering the outer liquid passageway 26 from the distribution conduit 53 passes along the passageway thus defined and flow through perforations formed in the outer wall means 13, to impinge against one surface of the textile web W.

The second pump 16, acting through the corresponding discharge conduit 44 and the corresponding distribution conduits 50, 54 directs portions of circulating liquid flow through the throat zone and into the treatment zone through the inner liquid passageway 25.

In operation of the apparatus as described to this point, the length of textile web W to be treated is arranged in an open width loop extending within a generally annular chamber and passing through the throat zone. Upon circulation of a flow of treatment liquid through the chamber, the portions of the circulating liquid directed through the throat zone by the distribution conduit 50, 51 move the looped textile web through the throat zone and through a treatment zone defined between the spaced inner and outer walls 12, 13. At the same time, the moving textile web is treated by the direction of other portions of the circulating liquid flow into the treatment zone through the inner and outer walls 12, 13, impinging the liquid against both surfaces of the textile web. Impingement of liquid against both surfaces of the open width textile web maintains the web in a loosely folded and fluidized state, to be contrasted with packed folds or creases such as has been encountered in prior apparatus and method. Thus, an active treatment of the web occurs throughout the throat and treatment zones due to agitated contact of treatment liquid with the textile web. Further, uniformity of conditions throughout the throat and treatment zones is promoted by cross-mixing and distribution of the treatment liquid and by distribution thereof through the inner and outer passageways 25, 26. Any change in treatment liquid characteristics proceeds substantially simultaneously throughout the throat and treatment zones.

These characteristics of the apparatus and method of the present invention are enhanced by the distribution of the perforations through the inner and outer walls means 12, 13. First, the perforations will be noted as being distributed over an arc of the annular chamber of at least 90°. Preferably (and as illustrated) the perforations are distributed over an arc of the annular chamber of about 200°. As so distributed, the perfora-

tions are more closely spaced toward points remote from the treatment zone distribution conduits 53, 54. Desirably, the spacing between perforations decreases, with distance away from the point at which treatment liquid is introduced into the passageways 25, 26, as a function of the liquid head pressure available, in order that flow of treatment liquid into the treatment zone will be equalized throughout the treatment zone. Such equalization contributes to maintaining the web W in a fluidized state.

Distribution of treatment liquid through the passageways 25, 26 provides at least two additional advantages. First, incoming treatment liquid in the passageways 25, 26 provides an insulating body between the treatment zone and the exterior of the apparatus of the present invention. Thus, heat loss from treatment liquid in the treatment zone is limited and more even temperature conditions are maintained. Second, flow of treatment liquid through the inner and outer wall means 12, 13 provides a boundary flow along the walls defining the annular chamber, to keep the fluidized web W out of contact with those walls and thereby promote more even treatment of the web.

It will be noted that the circulation of treatment liquid within the tank means 10 includes passage of liquid through a tapered wall portion 58 of the web guide means 11 and through the baffle means 32, 33. The tapered wall portion 58 nominally separates the treatment zone from the expansion zone, just as the baffle means 32, 33 nominally separate a portion of the annular chamber from the expansion zone. By withdrawal of liquid through the perforations in these members proper distribution of treatment liquid flow within the annular chamber is accomplished and movement of the web W is controlled in a desired manner.

Movement of the web W is also assisted by a lift roll 60, overlying the expansion zone. The lift roll 60 is shown to be formed as a generally cylindrical cage structure mounted on a central shaft 61 for rotation thereabout. In instances where the eduction action of the liquid flow through the throat zone is sufficient to motivate movement of the textile web W, the lifting roll 60 may rotate freely with movement of the web W and serve the function of lifting the web W above the body of treatment liquid retained within the tank means 10 and aligning the web W with the throat zone for entrance thereinto. However, the lift roll preferably is driven in rotation in order to control the speed of web movement. In the illustrated arrangement, a portion of the discharge from each of the pumps 15, 16 is withdrawn through a common discharge conduit 61. By means of a branch conduit 62, such withdrawn liquid flow may be delivered through turbine jet nozzles 64a, 64b, 64c, to be directed against a peripheral area of the lifting roll 60 and drive the roll in rotation to more positively lift the web W.

An alternate arrangement (not shown) which may be preferred in applications where high liquid levels are used within the tank means uses a solid roll as the lifting roll 60 and drives the roll by interconnection with a suitable electric or hydraulic motor outside or inside the tank means. This alternate arrangement decreases the possibility of whipping air into the treatment liquid while retaining control over web movement speed.

Advantage is also taken of the diversion of output flow from the pumps 15, 16 and the circulation pattern of treatment liquid through the tank means 10 in introducing treating agents such as dyestuffs. In particular, another branch conduit 68 leading from the discharge conduit 61 selectively directs discharge liquid to an eductor means 69. The eductor means 69 may be placed in operative communication with a feed tank means 70 in which a desired feed material such as a solution of a dyestuff may be contained. By passage of treatment liquid through the eductor means 69, the material to be fed into the apparatus is drawn into and mixed with the treatment liquid and is then delivered, through a delivery conduit 71, into the expansion zone within the tank means 10.

It is to be noted that such delivery of a treating agent results in mixture of the treating agent with the treatment liquid being withdrawn through the suction conduits 40, 41. Thus, the first appearance of a newly introduced treating agent occurs substantially simultaneously in the throat zone and in the treatment zone and any change in character of the treatment liquid is very quickly diffused throughout the entire apparatus.

It is contemplated by the present invention that the apparatus may be operated with any desired pressure conditions within the annular chamber. Thus, it may be desirable in some instances to operate under a pressurized condition, in some instances to operate under a vacuum condition, and in still other instances to operate under ambient atmospheric conditions. For these reasons, it is desirable that communication between the annular chamber and the ambient atmosphere be controlled by means of a vent conduit 72. The vent conduit 72 may be provided with appropriate pressure control valves and connections to pressure control apparatus, as desired.

Further, in order to provide for flushing of the annular chambers as may be required between processing cycles, a plurality of drain lines 74, 75, 76, 77 and 78 operatively communicate with various zones within the tank means 10. Provision is made for introduction of hot or cold water for flushing through an inlet conduit 79 communicating with the suction conduits 40, 41.

As has been pointed out hereinabove, the heat exchanger 42 is interposed between the discharge outlets of the pumps 15, 16 and the discharge conduits 44, 45 through which treatment liquid is recirculated to the tank means 10. In the apparatus of the present invention, the heat exchanger 42 exchanges heat between recirculating liquid being delivered by the pumps 15, 16 and a fluid heating exchange medium such as steam or water. The exchange of heat among three flows is done without intermixing of any two of the three flows and is accomplished in such a manner that temperatures of the two flows of recirculating treatment liquid are equalized. In accomplishing this important result for the apparatus and method of the present invention, reliance is placed upon a novel structure for the heat exchanger 42, now to be described with particular reference to FIGS. 7-10. The heat exchanger 42 includes an elongate housing means 90 within which are mounted first and second elongate tube bundles respectively identified as 91 and 92. Each of the tube bundles 91, 92 operatively communicates with a corresponding one of the pumps 15, 16 for receiving a cor-

responding flow of treatment liquid. Such communication is established by respective header means 93, 94 secured to opposite ends of the elongate housing means 90. Internal dividers 97, 98 within the header means 93, 94 cooperate with tube plates 99, 100 in which terminal ends of the two bundles are secured in assuring that treatment liquid delivered from the corresponding pump flows in the appropriate manner only through the corresponding tube bundle (as indicated in FIG. 7).

Medially within the elongate housing means 90 are conduit means 101, 102 communicating therewith for supplying fluid heat exchange medium thereto. The conduit means 101, 102 are aligned at diametrically opposite positions and are arranged medially of the length of the housing means 90 in order to aid in obtaining symmetrical distribution of flows through the heat exchanger 42 as will be described hereinafter.

Mounted within the housing means 90 are baffle means indicated as 104, 105a, 105b, 106, 107a, 107b, 108, 109, 110, 111a, 111b, 112, 113a, 113b and 114 which direct heat exchange medium flowing through the conduit means 101, 102 to follow a tortuous path within the housing 90 (as indicated by arrows in FIG. 7).

It will be noted that the flow of the three fluids through heat exchanger 42 is symmetrical, and that the directions of flow of the treatment liquid passing from the pumps 15, 16 is countercurrent. Further, the bilateral symmetry of the tube bundles about a plane through the longitudinal axis of the housing 90 tends to assure that temperature conditions of the treatment liquid flows are equalized. Such equalization is further assured by forming the tubes to be of the same diameter, wall thickness and overall free area and by equalizing the volume flow of treatment liquid therethrough.

In accordance with an important feature of the heat exchanger 42, the use of interleaved symmetrical U-tube bundles accommodates expansion and contraction due to thermal effects. Such accommodation is particularly necessary in view of the requirement that treatment liquid sometimes be heated by downward passage of steam through the conduit means 101, 102 and at other times be cooled by upward passage of water through the conduit means 102, 101 (as indicated in FIG. 3).

In the drawings and specification, there has been set forth a preferred embodiment of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed is:

1. Apparatus for liquid treatment of a textile material web in open width form comprising
  - tank means for containing a length of textile web to be treated as arranged in an open width loop, said tank means enclosing a generally annular chamber and including web guide means for forming a throat zone of generally rectangular cross-sectional configuration and further including spaced arcuate inner and outer wall means for defining a treatment zone adjacent to and of greater cross-sectional area than said throat zone, and
  - treatment liquid circulating means operatively communicating with said tank means for circulating a flow of treatment liquid through said chamber,

said circulating means including web moving means for directing portions of the circulating liquid flow through said throat zone for entraining the textile web therein and further including web treating means for directing portions of the circulating liquid flow into said treatment zone through said inner and outer all means for impinging the liquid against both surfaces of the textile web, whereby agitated contact of treatment liquid with the textile web occurs throughout the throat and treatment zones and thorough treatment of the textile web is thereby facilitated.

2. Apparatus according to claim 1 wherein said tank means further includes shell means extending generally parallel to said wall means for defining with said wall means liquid flow passageways and further wherein said wall means define perforations for operative communication between said passageways and said treatment zone, said, perforations being distributed in a predetermined manner over a predetermined arc of said annular chamber for subjecting the moving textile web to predetermined agitated treatment in both said throat and treatment zones.

3. Apparatus according to claim 2 wherein said perforations are distributed over an arc of said annular chamber of at least 90°.

4. Apparatus according to claim 2 wherein said perforations are distributed over an arc of said annular chamber of about 200°.

5. Apparatus according to claim 1 wherein said tank means further includes baffle means for forming an expansion zone at least partially within said chamber and for retaining a predetermined depth of liquid within said chamber while receiving in said expansion zone any excess of liquid above that required for maintenance of such depth of liquid and further wherein said circulating means includes pump means operatively communicating with said expansion zone for withdrawing liquid therefrom and for recirculating withdrawn liquid to both the throat and treatment zones.

6. Apparatus according to claim 5 further comprising means operatively communicating with said expansion zone for introducing treating agents thereinto for intermixing with treatment liquid during withdrawal and recirculation thereof whereby dilution of treating agents prior to contact thereof with a textile web being treated is facilitated.

7. Apparatus according to claim 5 further comprising heat exchanger means operatively interposed between said pump means and said throat and treatment zones for exchanging heat between recirculating liquid and a fluid heat exchange medium.

Apparatus according to claim 1 wherein said circulating means comprises conduit means operatively communicating with said annular chamber for withdrawal of liquid therefrom and operatively communicating with said throat and treatment zones for distributing recirculated liquid across the width of the textile web whereby continuing mixing of the circulating liquid facilitates maintenance of uniform conditions throughout the chamber.

9. Apparatus according to claim 8 wherein said conduit means communicates with said chamber at a plurality of locations therewithin for withdrawal of a cor-

responding plurality of flows of liquid therefrom and communicates with said throat and treatment zones through a corresponding plurality of distributive paths so as to promote the continuing mixing of the circulating liquid.

10. Apparatus for liquid treatment of a textile material web in open width form comprising an enclosing shell means for retaining a body of treatment liquid,

spaced arcuate inner and outer wall means within said shell means and forming an arcuate portion of a generally annular chamber for receiving open width loop of textile web to be treated, said wall means being spaced from said shell means for defining therebetween corresponding inner and outer liquid flow passageways and having perforations for directing flow of treatment liquid from said passageways into a treatment zone extending over a predetermined arc of said annular chamber,

web guide means located within said shell means adjacent one end of said arcuate portion formed by said wall means, said web guide means forming a throat zone of generally rectangular cross-sectional configuration for passage of looped textile web into said treatment

baffle means within said shell means for forming an expansion zone and for establishing a predetermined depth for said body of liquid retained within said shell means, and

pump means operatively communicating with said shell means for withdrawing treatment liquid therefrom and for recirculating withdrawn treatment liquid thereto, said pump means communicating with said expansion zone for withdrawing liquid from a plurality of locations therein and communicating with said throat zone and liquid flow passageways for distributing corresponding portions of recirculated treatment liquid thereacross widthwise of the textile web being treated, said pump means inducing textile web entraining flow of treatment liquid through said throat zone for moving the looped textile web within said annular chamber and inducing textile web treating impingement of treating liquid against both surfaces of textile web in said treatment zone.

11. Apparatus according to claim 10 wherein said pump means comprises first and second pumps each communicating with said expansion zone at a corresponding one location and each communicating with a corresponding one of said inner and outer liquid flow passageways and with one side of said throat zone whereby continuing mixing of two flows of treatment liquid circulated by said first and second pumps is facilitated.

12. Apparatus according to claim 11 further comprising heat exchange means interposed between said first and second pumps and said shell means for receiving corresponding flows of circulating treatment liquid discharged from said pumps and for exchanging heat between said corresponding flows of circulating treatment liquid and a fluid exchange medium.

13. Apparatus according to claim 12 wherein said heat exchange means comprises an elongate housing means, first and second elongate tube bundles mounted

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within said housing means and operatively communicating with corresponding ones of said pumps for receiving corresponding flows of treatment liquid, conduit means communicating with said housing means for supplying fluid exchange medium thereto and baffle means within said housing means for directing flow of fluid exchange medium therethrough, said tube bun-

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dles, conduit means and baffle means cooperating in distributing flows through said heat exchange means symmetrically for evenly exchanging heat therebetween so as to equalize the temperatures of said flows of treatment liquid.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,685,325 Dated August 22, 1972

Inventor(s) William T. Carpenter

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, Line 41, "mean" should be --means--  
Column 5, Line 21, "flow" should be --flows--  
Column 7, Line 41, "mad" should be --made--  
Column 8, Line 43, "colled" should be --cooled--  
Line 44, after "101", delete -- ) --

IN THE CLAIMS:

Column 9, Line 7, "all" should be --wall--  
Line 8, "Of" should be --of--  
Line 54, before "Apparatus", insert --8.--  
Column 10, Line 14, "she60" should be --shell--  
Line 18, "treatmzone" should be --treatment zone--  
Line 25, after "treatment", insert --zone,--

Signed and sealed this 1st day of May 1973.

(SEAL)  
Attest:

EDWARD M. FLETCHER, JR.  
Attesting Officer

ROBERT GOTTSCHALK  
Commissioner of Patents