

- [54] **STEAM DISPERSION MANIFOLD**  
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**Related U.S. Application Data**

- [63] Continuation of Ser. No. 69,215, Sept. 3, 1970, abandoned.  
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[51] Int. Cl. .... **B05b 1/24**  
[58] Field of Search ..... 239/132, 135, 139; 126/13; 165/154

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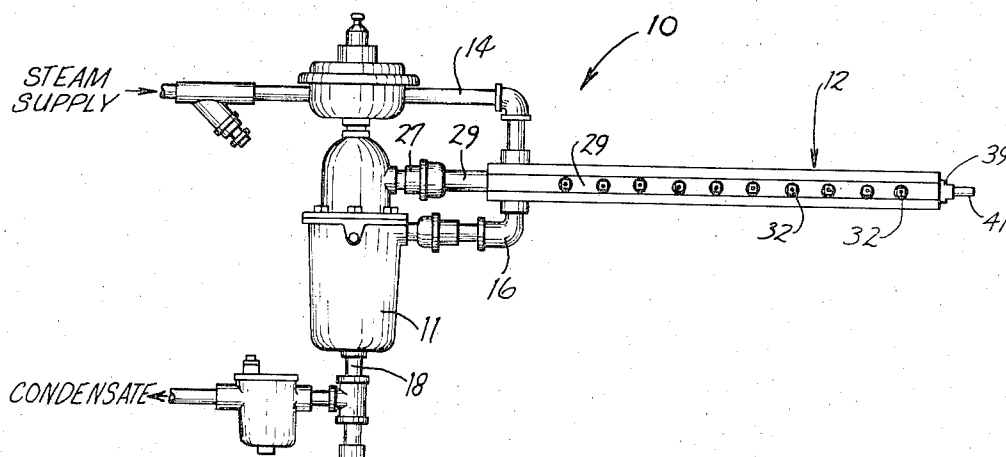
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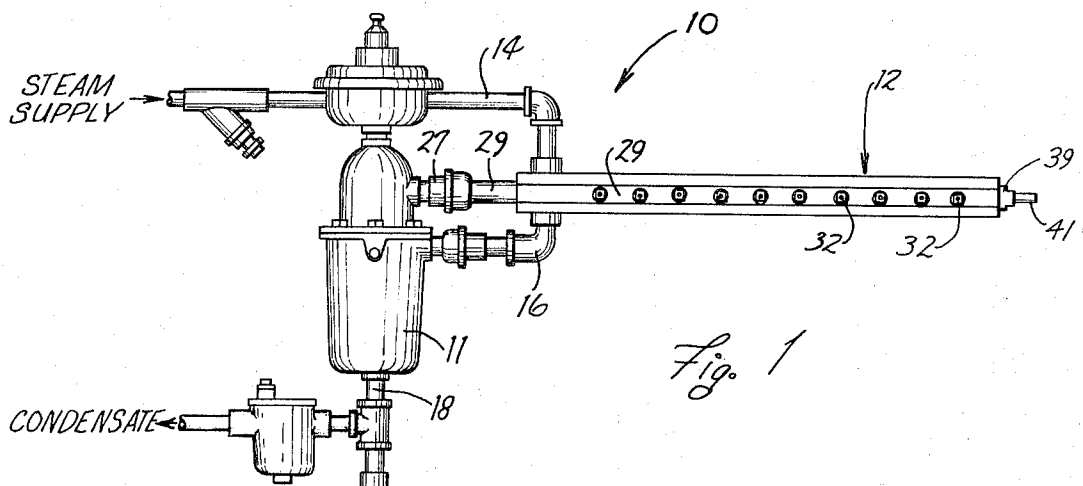
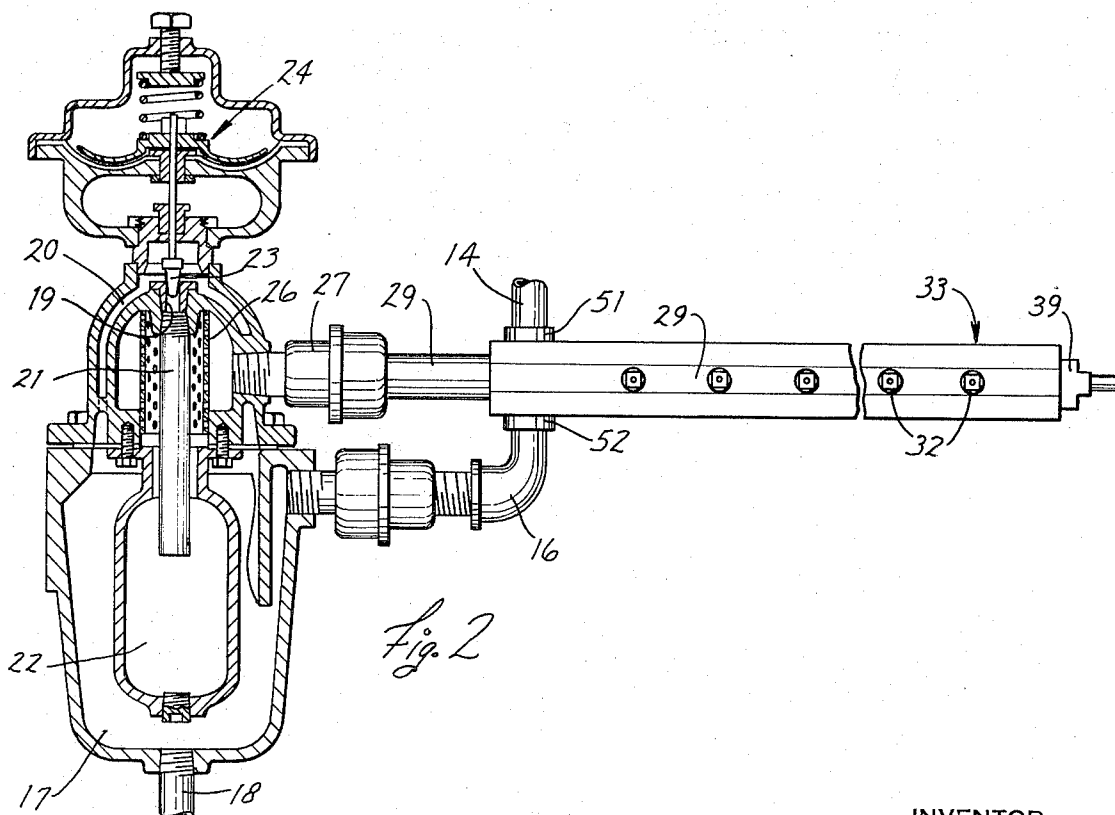
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[57] **ABSTRACT**

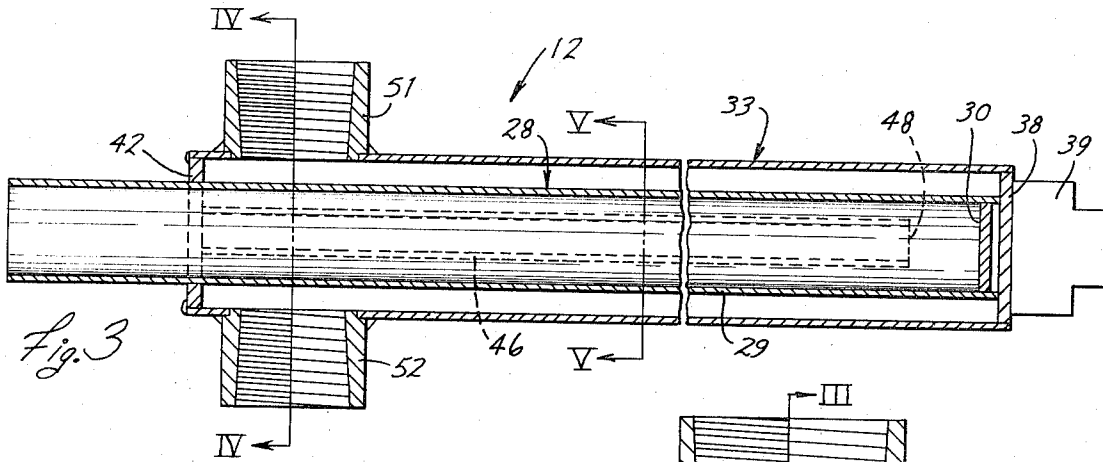
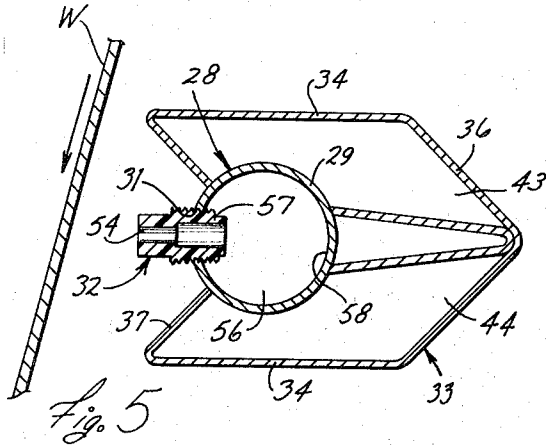
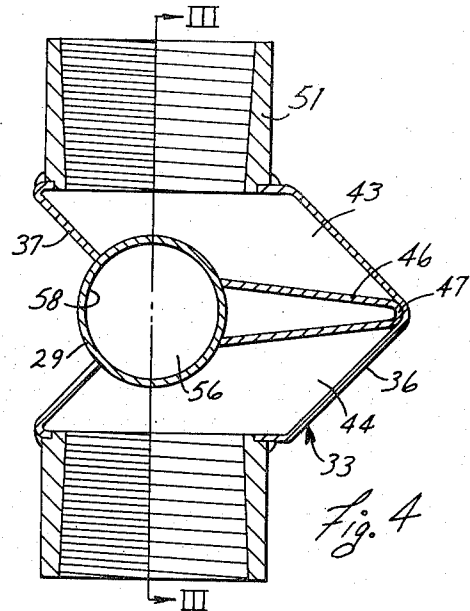
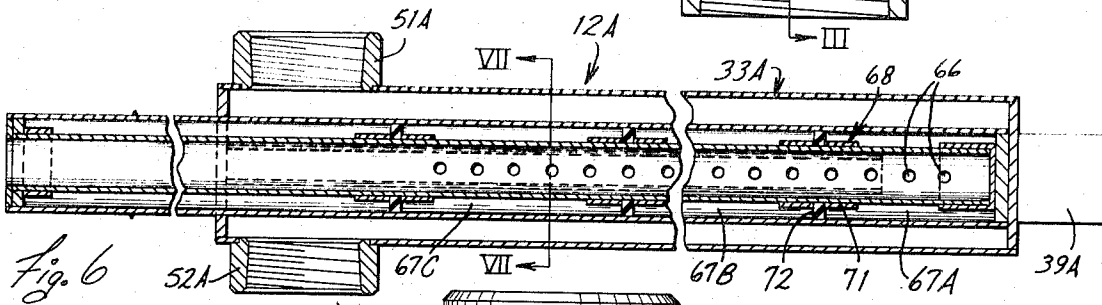
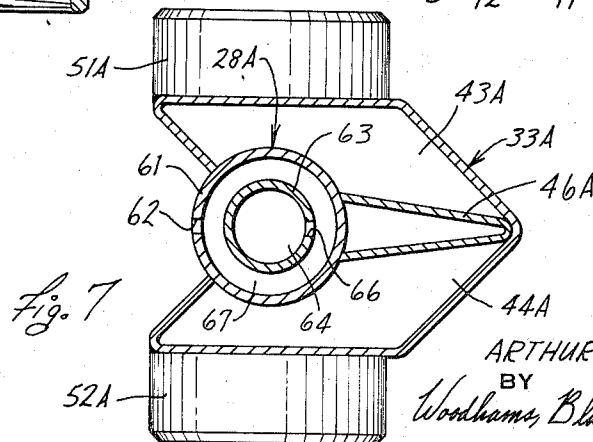
A steam shower system having an improved manifold assembly for discharging dry steam uniformly through a plurality of spaced discharge orifices. The discharge orifices of the manifold extend over a substantial length, such as up to about twelve feet. The manifold is constructed so that it can be used for effecting even distribution of dry steam in order to maintain or provide proper moisture conditions in travelling sheets or webs of approximately the same width. The manifold assembly includes an elongated steam discharge conduit having said plurality of discharge nozzles spaced longitudinally along one side thereof. Portions of the nozzles extend into the interior of the discharge conduit for breaking up the free flow of steam through the conduit so as to result in substantially uniform flow or dispersion of steam through each nozzle orifice. In a modification of the invention the steam discharge manifold includes inner and outer concentric tubes respectively having discharge orifices angularly spaced approximately 180 degrees apart with the annular chamber between the tubes being divided by baffles into a plurality of axially spaced subchambers. The discharge orifices associated with the different subchambers are of different sizes so as to compensate for pressure differences within the different subchambers so as to provide for uniform dispersion of steam over the entire longitudinal length of the manifold assembly.

11 Claims, 7 Drawing Figures





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## STEAM DISPERSION MANIFOLD

This is a continuation of application Ser. No. 69,215, filed Sept. 3, 1970, now abandoned.

### FIELD OF THE INVENTION

This invention relates to a system for preventing loss of moisture from, or effecting addition of moisture to, travelling sheets of material, which material may be hygroscopic and, in particular, relates to an improved elongated manifold assembly for uniformly distributing dry steam through a plurality of orifices which are spaced apart longitudinally over the entire length of the elongated manifold assembly.

### BACKGROUND OF THE INVENTION

Humidifying devices for discharging or dispersing dry steam, such as for humidifying the air flowing in a duct in a building, are well known and one such device is disclosed in U.S. Pat. No. 3,386,659, which patent is assigned to the same assignee as this application. Humidifying devices of the type disclosed in the above-mentioned patent are widely used and operate satisfactorily. It is desired to provide an improvement in the form of a steam shower system for humidifying sheets or webs, which system incorporates some of the advantageous structural features of the prior humidifying device, but which also includes additional structural features that make it capable of solving additional problems. For example it is difficult to obtain uniform distribution of steam over the entire longitudinal length of a manifold of substantial length, such as up to about twelve feet in length. This does not create a serious problem when the steam is discharged into a duct, but it can be a substantial difficulty when the steam is to be uniformly distributed in an unconfined space. Examples of installations in which such conditions are present include those involving the humidification of textile or paper webs and the like during processing thereof.

The known humidifier manifold utilizes a tubular steam dispersion conduit having a plurality of radially directed dispersion orifices disposed in an axially extending row along one side of the dispersion conduit. As applied to humidifier manifolds of substantial length, due to the flow characteristic of the steam throughout the length of the tube, and additionally due to the pressure drop along the length of the dispersion conduit, the amount of steam discharged through the orifices adjacent one end of the dispersion conduit can be substantially different from the amount of steam discharged through the orifices adjacent the other end of the discharge conduit. While this is not a problem when the steam is distributed in a flowing air stream in a duct, the commercial requirements for effecting uniform humidification of a moving web of material of several feet or more in width cannot be met effectively by the prior construction. A further significant requirement is that the humidification must be uniform even though the ambient air conditions may vary widely in temperature and relative humidity.

A still further unique requirement associated with the humidification of sheets and webs is that, in most cases, the creation of water spots on the sheet or web must absolutely be avoided. Thus, the humidifier manifold must be capable of supplying absolutely dry steam at a uniform rate and distribution over an extended length

using a compact apparatus which can be operated using relatively low pressure steam under widely different and variable humidity conditions. The present invention is intended to meet this need.

The objects of the present invention include:

1. To provide an improved steam shower system for a humidifier system which results in an even and uniform dispersion of dry steam over the complete longitudinal length thereof.
2. To provide a steam shower system, as aforesaid, which avoids spitting or dripping of water particles from the discharge orifices, even when the discharge orifices are directed downwardly.
3. To provide a steam shower assembly, as aforesaid, having nozzle members which project into the interior of the steam dispersion conduit for breaking up the free flow of steam through the conduit to result in an even and uniform dispersion of steam through all of the nozzle orifices.
4. To provide a steam shower assembly, as aforesaid, wherein when the nozzle orifices are directed downwardly, the individual nozzle members project upwardly into the interior of the steam dispersion conduit, thereby preventing dripping or spitting of water through the nozzle orifices.
5. To provide a modified steam shower assembly, as aforesaid, which utilizes concentric inner and outer dispersion tubes having orifices displaced 180° from one another with the chamber between the tubes being divided into a plurality of isolated, axially spaced subchambers for compensating for pressure variations over the longitudinal length of the manifold assembly, the discharge orifices associated with the different subchambers being of varying sizes to compensate for the pressure variations in the different subchambers whereby a substantially uniform and even dispersion of steam occurs over the entire longitudinal length of the manifold assembly.

Other objects and purposes of the invention will be apparent to persons acquainted with devices of this type upon reading the following specification and inspecting the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a humidifier system employing a steam shower assembly according to the invention.

FIG. 2 is an enlarged view similar to FIG. 1 and showing the steam control unit in cross section.

FIG. 3 is a longitudinal sectional view of the improved steam shower assembly constructed according to the present invention, as taken substantially along the line III—III of FIG. IV.

FIG. 4 is an enlarged transverse section as taken along the line IV—IV of FIG. 3.

FIG. 5 is an enlarged transverse section as taken along the line V—V of FIG. 3.

FIG. 6 is a view similar to FIG. 3 and illustrating a modified construction of the steam shower assembly.

FIG. 7 is an enlarged transverse section as taken along the line VII—VII of FIG. 6.

Certain terminology will be used in the following description for convenience in reference only and will not be limiting. The words "upwardly," "downwardly," "rightwardly" and "leftwardly" will refer to directions in the drawings to which reference is made. The words "inwardly" and "outwardly" will refer to directions to-

ward and away from, respectively, the geometric center of the device and associated parts thereof. Said terminology will include the words above specifically mentioned, derivatives thereof and words of similar import.

While the drawings all disclose the manifold assembly positioned so that the discharge orifices are directed horizontally, it will be readily recognized that this orientation has been disclosed merely for convenience since the manifold assembly could readily be positioned so that the discharge orifices open downwardly and, in fact, one of the significant advantages of the improved manifold assembly according to the present invention, namely the prevention of dripping or spitting, occurs when the manifold assembly is positioned so that the discharge orifices are directed downwardly. However, the present invention is deemed to encompass any selected orientation of the manifold and of the discharge orifices, including a horizontal orientation of the discharge orifices as illustrated in the drawings.

### SUMMARY OF THE INVENTION

The objects and purposes of the present invention are met by providing an elongated steam shower assembly having a steam dispersion conduit which is closed at one end and has a plurality of spaced discharge orifices along one side thereof. Steam, preferably at a pressure level slightly greater than atmospheric, is supplied to the other end of the discharge conduit, which steam is then dispersed through said plurality of orifices. The individual orifices are preferably defined by means of nozzle members which extend into the interior of the discharge conduit for breaking up the free flow of steam longitudinally of the conduit, whereby a substantially uniform and even dispersion of steam occurs through each of the discharge orifices, irrespective of the location of the orifice along the longitudinal length of the discharge conduit. The nozzle members, by projecting inwardly into the interior of the discharge conduit, also prevent dripping or spitting of water through the discharge orifices, even when the discharge orifices are directed so as to open downwardly. While the individual nozzles can be adjustable if desired so as to permit the orifice area to be selectively varied, it has been found that fixed nozzles can be utilized with the nozzles all having a uniform flow area inasmuch as the projection of the nozzle into the interior of the conduit is sufficient to result in substantially uniform distribution of steam through all of the discharge orifices.

In a modification of the present invention, the discharge conduit includes inner and outer concentric tubes each having a plurality of discharge orifices spaced along one side thereof, with the discharge orifices in the inner tube being displaced approximately 180° from the discharge orifices in the outer tube whereby the steam thus has to undergo a change of direction of approximately 180° when flowing through the annular chamber provided between the concentric tubes. The annular chamber between the concentric tubes is also preferably divided into a plurality of axially isolated subchambers by means of intermediate baffles whereby the concentric tubes minimize or substantially prevent condensation within the inner tube. The discharge orifices associated with each subchamber are of substantially constant flow area, but the orifices associated with the different subchambers can be

of selectively different flow areas over the longitudinal length of the manifold so as to compensate for the different pressure levels which exist within the different axially spaced subchambers, thereby enabling uniform or even dispersion of steam from all of the discharge orifices.

### DETAILED DESCRIPTION

FIGS. 1 and 2 illustrate therein a steam humidifier system 10 which includes a conventional steam control unit 11 for supplying dry steam to a manifold assembly 12 which, according to the present invention, is designed to provide uniform steam dispersion through a plurality of axially spaced orifices and to also prevent dripping or spitting of water droplets, particularly when the orifices are disposed so as to open downwardly. The manifold 12 may be disposed above, below or side-wardly of a moving sheet with the orifices opening toward the sheet so as to discharge dry steam thereagainst. The abovementioned examples merely represent possible modes of use of the humidifier system according to the present invention. However, such humidifier systems are utilized in many different situations and environments, and the system according to the present invention is obviously intended for use within these many different use situations and environments.

The humidifier system 10 utilizes a steam supply pipe 14 which at its remote end (not shown) is connected to a supply of steam. The incoming steam within the supply pipe 14 is preferably at a pressure above atmospheric pressure. The steam may be at a pressure of up to 60 psig, but in most installations the steam is supplied to the pipe 14 at pressures in the 5 to 15 psig range. The steam is supplied to the interior of a jacket (to be described in detail hereinafter) which comprises a portion of the manifold assembly and into the pipe 16 which then supplies the steam to a separating chamber 17 formed within the steam control unit 11. Any condensation which collects within the separating chamber 17 flows downwardly through the discharge or drain line 18.

The steam within the separator chamber 17 then flows upwardly into the upper chamber portion 20 and thence flows through the orifice 19 and through the conduit 21 into the steam-jacketed reevaporation chamber 22, the flow of steam through the orifice 19 being controlled by means of a movable valve 23, which valve is in turn controlled by means of an actuator mechanism 24. The actuator mechanism 24 can be electrically, pneumatically or manually operated. The steam within reevaporation chamber 22 then flows upwardly around the outer periphery of the conduit 21 into the interior of the muffler 26, whereupon the steam then flows outwardly through the perforated walls of the muffler 26 into the outlet pipe 27, which pipe 27 is in turn connected to the manifold assembly 12.

The steam control unit 11, as briefly described above, is conventional and well known and thus further detailed description thereof is not believed necessary.

Considering now the manifold assembly 12 (FIG. 3-5), same includes a steam dispersion tube assembly 28 which is connected to the outlet pipe 27 for receiving steam at the dispersion pressure from the steam control unit 11. The steam dispersion tube assembly 28

includes an elongated dispersion tube 29 which is open at one end (leftward end in FIG. 3) for connection to the outlet pipe 27 so that steam may flow from the steam control unit 11 into the interior of the dispersion tube 29. The other end of the dispersion tube is closed by means of an end wall 30. The tube 29 has a plurality of longitudinally spaced openings 31 extending through the wall thereof, which openings are disposed along a row which extends substantially axially of the tube 29. The openings 31 are threaded and receive therein removable nozzles 32 for permitting dispersion of dry steam.

The manifold assembly 12 further includes a jacket or outer shell 33 partially surrounding the dispersion tube 29 over a major portion of the length thereof. The jacket 33 functions as a temperature maintaining means for substantially preventing condensation of steam within the dispersion tube 29. The jacket 33 is of substantially conventional construction (see U.S. Pat. No. 3,386,659, issued June 4, 1968, and owned by the assignee of this application) and specifically includes parallel sidewalls 34 spaced from the steam dispersion tube 29, and outer wall 36 which comprises an inwardly facing angled section, and inwardly converging inner walls 37.

The jacket 33 is desirably formed of one piece of sheet stock, the edges of the inner walls 37 being secured to the dispersion tube 29 in laterally spaced relation to and on opposite sides of the row of discharge nozzles 32. The outer end of jacket 33 is preferably closed by means of an outer end wall 38 adapted to have a support member or tee 39 mounted thereon, which support member 39 is adapted to receive a mounting or coupling member 41 (FIG. 1) for enabling the outer end of the manifold assembly 12 to be suitably supported. The inner end of the jacket 33 is closed by a further end wall 42 through which extends the steam dispersion tube 29.

The jacket 33 is divided into longitudinally extending inlet and outlet passages 43 and 44, respectively, by means of a longitudinally extending partition or spacer 46 which, in the embodiment illustrated, is of folded stock of generally V-shaped cross section. The bight 47 of the partition 46 is engaged within the apex of the outer wall 36, and the inner arm portions of the partition 46 are supportedly engaged and connected to the steam dispersion tube 29 (FIG. 5). The outer end 48 of the partition 46 is spaced from the end wall 38 so that steam may flow around the end of the partition from the inlet passage 43 into the outlet passage 44. The jacket 33 adjacent its inner end is also provided with inlet and outlet couplings 51 and 52, respectively, which couplings are respectively connected to the pipes 14 and 16 for providing communication with the passages 43 and 44.

Considering now the nozzles 32, which nozzles are preferably identical, each is provided with an orifice 54 extending therethrough, which orifice provides for flow of steam therethrough from the passageway 56 as defined within the dispersion tube 29 and the surrounding atmosphere. The nozzle 32 includes an inner portion 57 which projects inwardly into the passage 56 beyond the inner peripheral wall 58 of the tube 29, which rear wall portion 57 acts as an obstruction to the free flow of steam longitudinally through the passage 56 and also prevents condensate from dripping or being discharged through the orifice 54, particularly when the orifice 54

is directed vertically downwardly. The nozzle 32 is preferably constructed of plastic and, if desired, may be of a standard adjustable type so as to enable the size of the orifice 54 to be selectively varied.

As indicated schematically in FIG. 5, in a typical installation the manifold orifices 54 open toward a web W moving therepast so as to effect humidification thereof. In some cases the steam shower provides a high humidity zone next to the web, while in other installations a film of moisture forms on the web.

## OPERATION

The operation of the manifold assembly constructed according to the present invention will be briefly described to ensure a complete understanding thereof.

Steam will be supplied from a source (not shown) through supply pipe 14 into the jacket 33, whereupon steam will then flow through the inlet passage 43 and into the outlet passage 44 and thence through the pipe 16 into the separating chamber 17. Any condensation which may have formed during this stage of the flow will collect within the bottom of chamber 17 and will be discharged into the drain line 18. The steam will then flow through the orifice 19 into the reevaporation chamber 22, which steam will then flow upwardly into and through the muffler 26 and thence into the outlet pipe 27. Steam supplied to outlet pipe 27 will then flow longitudinally through the passage 56 formed within the dispersion tube 29, with the dry steam then being uniformly dispersed throughout the longitudinal length of the tube 29 by flowing outwardly through the orifices 54 formed within the nozzles 32. The jacket 33 is provided to at least partially insulate the steam in the dispersion tube 29 and to prevent or at least minimize the condensation of steam therein, the temperature of the steam within the jacket 33 being such that it substantially evaporates the condensate which may be present in the steam dispersion tube 29. However, it will be recognized that the possibility exists that at least some condensate may become present within the dispersion tube 29, particularly tubes of substantial length, which condensate may cause undesirable dripping or spitting of water particles.

The spitting or dripping of water particles from the manifold assembly is, according to the present invention, substantially eliminated due to the provision of the nozzles 32. Particularly, when the nozzles 32 are directed downwardly, any condensate which collects within the bottom of the tube 29 is prevented from dripping from the tube 29 due to the fact that the inner portion 57 of each nozzle 32 projects into the interior of the passage 56. The inner end of the orifice 54 is thus disposed upwardly from the lowermost point of the passage 56 as defined within the tube 29, whereby any condensate that becomes present will then collect adjacent the lowermost portion of the passageway but will be prevented from freely flowing into the orifices 54. The inwardly projecting nozzles will thus permit any condensate that becomes present to collect within the bottom of the tube 29 while at the same time will prevent the condensate from being discharged through the orifices. This will thus enable the condensate to again reevaporate so as to be discharged in the form of steam.

To ensure that substantially equal quantities of dry steam are dispersed through each of the axially spaced nozzles 32, the rate of flow of the steam into the disper-

sion tube 29 is preferably maintained slightly above the rate at which it can be discharged through the orifices 54. In order to provide this rate of flow relationship, the total flow area as defined by the sum of the cross sectional areas of the plurality of orifices 54 is more than the area of the flow orifice 19 as formed in the steam control unit 11. Since the steam as supplied to the separating chamber 17 is normally above atmospheric pressure, this thus results in the steam within the dispersion tube 29 being slightly pressurized, thereby assisting the even distribution or dispersion of steam throughout the plurality of spaced orifices 54.

However, of perhaps even more importance as regards the even or uniform dispersion of steam throughout the plurality of spaced orifices is the fact that the nozzles 32 extend into the interior of the pipe 29 so as to break up or disrupt the longitudinal flow of steam, and thereby provide for substantially equal or uniform dispersion of steam through all of the longitudinally spaced nozzles. One of the serious problems which has been encountered with the known manifold assemblies has been the inability to provide uniform or equal dispersion of steam from the manifold assembly over the complete longitudinal length thereof, which nonuniform dispersion results from the fact that the steam is normally supplied to the manifold at only one end thereof. However, Applicant has discovered that a substantially uniform dispersion of steam over substantially the complete longitudinal length of the manifold can be achieved, even when the steam is supplied at only one end of the manifold, by permitting the nozzle members to project inwardly into the interior of the steam dispersion tube so that the nozzles act as obstructions to the free flow of steam through the longitudinal length of the dispersion tube. While the exact reason for this mode of operation is not known, it is believed that the inwardly projecting nozzles act as obstructions so as to cause some of the velocity energy of the flowing steam to be converted into pressure energy, that is, a conversion from velocity to static pressure, which thus results in localized higher pressure areas surrounding each of the nozzles, which pressure areas are at a pressure level greater than the atmospheric pressure adjacent the external end of the nozzle whereby a substantially uniform pressure drop occurs across each nozzle so that substantially uniform quantities of dry steam are dispensed through each of the nozzles 54, irrespective of the location of the nozzle along the longitudinal length of the manifold assembly.

The nozzles 32, when constructed according to the present invention, thus provide for a more uniform distribution or dispersion of steam over the complete longitudinal length of the manifold assembly, and additionally prevent dripping or spitting of water particles when the manifold is mounted so as to have its orifices directed downwardly.

#### MODIFICATION

FIGS. 6 and 7 illustrate therein a manifold assembly 12A which represents a modification of the manifold assembly 12 illustrated in FIGS. 3-5. Since these two manifold assemblies contain many identical or substantially identical corresponding parts, the parts or elements of the manifold assembly 12A will be referred to by the same reference numerals designating corresponding parts of the manifold assembly 12 but with the suffix "A" added thereto.

The manifold assembly 12A as illustrated in FIGS. 6 and 7 is identical to the manifold assembly 12 described above except for the steam dispersion tube assembly 28A, which assembly includes an outer dispersion conduit 61 having a plurality of steam dispersion orifices 62 formed therein, which orifices 62 are disposed in a row which extends axially of the conduit 61 with the orifices 62 being substantially uniformly spaced over a major portion of the longitudinal length of the tube 61. The steam dispersion tube assembly 28A also includes an inner dispersion conduit 63 disposed concentrically within the outer dispersion conduit 61. The inner dispersion conduit 63 has a steam supply passage 64 extending longitudinally throughout the length thereof, which passage 64 is closed at its outer end and is open at its inner end for communicating with the outlet pipe 27 of the steam control unit 11.

The inner dispersion conduit 63 also has a plurality of openings or orifices 66 extending through the wall thereof, which openings are disposed in an axially directed row and are substantially uniformly spaced throughout the length of the tube 63. As illustrated in FIG. 7, the orifices 66 are angularly displaced substantially 180° from the orifices 62. The orifices 66 thus provide for communication between the passage 64 and the annular chamber 67 as defined between the conduits 61 and 63.

The annular chamber 67, as defined between the tubes 61 and 63, is divided into a plurality of axially spaced subchambers, such as subchambers 67A, 67B, 67C, by means of baffle units 68 disposed between the conduits 61 and 63. The baffle units 68 each include an annular ring-like seal member 72 disposed between and in sealing engagement with the conduits 61 and 63, the seal member 72 being retained in place by means of elongated sleeves 71 disposed on opposite sides of the seal member 72 in surrounding relationship to the inner conduit 63. The baffle units 68 thus substantially isolate the subchambers, such as 67A and 67B, from one another.

The manifold assembly as illustrated in FIGS. 6 and 7 operates in substantially the same manner as is true of the manifold assembly illustrated in FIGS. 1-5. That is, steam as supplied from the steam control unit 11 flows into the inner dispersion conduit 63, whereupon the steam then flows outwardly through the orifices 66 into the plurality of axially separated subchambers 67A, 67B and 67C, with the steam then being dispersed outwardly through the discharge orifices 62. This specific configuration of the manifold assembly is desirable since the dispersion tube assembly includes inner and outer tubes disposed in surrounding relationship to one another, the inner tube 63 being completely surrounded by the outer tube 61 so that little, if any, condensation will occur within the inner tubes 63.

Further, this construction of the manifold assembly is also desirable for use with manifold assemblies having extremely long lengths since the intermediate annular chamber 67 can be selectively divided into a plurality of axially spaced subchambers by means of the baffle units 68, which baffle units result in the pressure within each individual subchamber being substantially constant. However, inasmuch as the pressure of the steam tends to vary over the longitudinal length of the manifold assembly, particularly when the manifold assembly is of substantial length, the pressure of the

steam within the subchamber adjacent one end of the manifold may be substantially different from the pressure of the steam contained within the subchamber adjacent the other end of the manifold. This pressure variation over the length of the manifold will, if not compensated for, result in uneven dispersion or discharge of steam over the length of the manifold. Accordingly, in the present invention the discharge orifices 66 and/or 62 associated with the different subcompartments can be made so as to have slightly different flow areas so as to compensate for the pressure variation between the different subcompartments, thereby enabling substantially uniform flow or dispersion from each of the discharge orifices, irrespective of the location of the orifice relative to the longitudinal length of the manifold. For example, if the subcompartment adjacent one end of the manifold assembly contains steam which has a substantially lower pressure than the subcompartment adjacent the other end of the manifold, then the orifices associated with said one subcompartment will be of larger area than the orifices associated with said other subcompartment so that the orifices associated with both end subcompartments will discharge substantially uniform quantities of steam. However, all of the discharge orifices associated with a single subcompartment will be of substantially constant area inasmuch as the steam pressure within the individual subcompartment is substantially uniform.

While particular preferred embodiments of the invention have been disclosed above for illustrative purposes, it will be recognized that variations or modifications of the disclosed apparatus, including the rearrangement of parts, lie within the scope of the present invention.

The embodiments of the invention in which I claim an exclusive property or privilege are defined as follows:

1. A humidifier for discharging dry steam, comprising;

an elongated hollow steam discharge conduit, said steam discharge conduit being closed at one end thereof and being adapted to be connected to a supply of steam adjacent the other end thereof for permitting steam to flow longitudinally through said discharge conduit;

a row of spaced flow nozzles attached to said steam discharge conduit along one side thereof, said flow nozzles each having a discharge orifice there-through in communication with the interior of said discharge conduit, said nozzles including a tubular wall extending inwardly into the interior of said discharge conduit so that the inner end of said discharge orifice is disposed inwardly from the inner peripheral wall of said discharge conduit to disrupt the free flow of steam in said discharge conduit;

an elongated second conduit outside of and extending along the length of said discharge conduit and defining a steam receiving chamber in heat transfer relationship with said discharge conduit;

inlet and outlet couplings connected to said second conduit and adapted for connection to a supply of steam so that flow of steam into and through said chamber at least minimizes condensation of the steam flowing within said discharge conduit, the outer ends of the discharge orifices formed in said flow nozzles communicating directly with the atmosphere surrounding said conduits for permitting

dry steam within said discharge conduit to flow directly into said atmosphere; and

a steam control unit connected between said outlet coupling and the other end of said steam discharge conduit, said steam control unit having means for separating condensate from the steam leaving said second conduit so that dry steam is supplied to said steam discharge conduit, said steam control unit having a flow control orifice, the cross-sectional area of said flow control orifice being selected with respect to the sum of the cross-sectional areas of the discharge orifices so that the steam in the steam discharge conduit is at least slightly pressurized.

2. A humidifier according to claim 1, wherein said tubular wall of said flow nozzle comprises an annular wall projecting radially into the interior of said discharge conduit a substantial distance inwardly from said inner peripheral wall, the inner end of said discharge orifice thus being disposed inwardly a substantial distance from said inner peripheral wall, said discharge orifice extending substantially radially relative to said discharge conduit whereby said inwardly projecting annular wall disrupts the free flow of steam longitudinally of said discharge conduit so as to cause uniform dispersion of steam through said plurality of flow nozzles.

3. A humidifier according to claim 2, wherein each flow nozzle comprises a synthetic resin nozzle member threaded into an opening formed in the wall of said discharge conduit, said nozzle member having a stepped central bore therethrough with the wide end of said bore opening into said discharge conduit and the narrow end of said bore opening to the ambient atmosphere, the outer end of said nozzle projecting outwardly from said discharge conduit so that said outer end is spaced radially outwardly from said discharge conduit.

4. A humidifier according to claim 2, wherein said second conduit embraces said discharge conduit except for a relatively narrow segment thereof having the flow nozzles secured thereto, said second conduit having spaced apart opposite continuous longitudinal edges affixed to the outer surface of said steam discharge conduit and in sealing relationship therewith along the entire length thereof on respectively opposite sides of said row of flow nozzles.

5. A humidifier according to claim 4, in which the inlet and outlet couplings are connected to the second conduit adjacent one end thereof, and a transverse partition disposed in said chamber and fixedly connected to and extending between said discharge conduit and said second conduit for dividing said chamber into an inlet passage that communicates with the inlet coupling and an outlet passage that communicates with the outlet coupling, said partition extending from said one end of said second conduit to a position adjacent to but spaced from the other end of said second conduit so that said inlet and outlet passages are in communication with each other adjacent said other end of said second conduit.

6. A humidifier according to claim 1 wherein the cross-sectional area of said flow control orifice is less than the sum of the cross-sectional areas of the discharge orifices so that the steam in the steam discharge conduit is at least slightly pressurized.

7. A humidifier according to claim 1 wherein the cross-sectional area of said flow control orifice is more

than the sum of the cross-sectional areas of the discharge orifices so that the steam in the steam discharge conduit is at least slightly pressurized.

8. A humidifier for discharging dry steam, comprising:

an elongated, hollow, inner steam discharge conduit closed at one end and adapted to be connected to a supply of steam adjacent the other end thereof, said inner discharge conduit having a plurality of spaced discharge openings disposed in a row along one side thereof;

an elongated, intermediate steam discharge conduit disposed substantially concentric with and in surrounding relationship to said inner conduit, said intermediate conduit extending over at least a major portion of the length of the inner conduit and defining an intermediate steam receiving chamber between said inner and intermediate conduits in surrounding relationship to said inner conduit, the opposite axial ends of said chamber being substantially closed;

said intermediate discharge conduit also having a plurality of spaced discharge orifices disposed in a row along one side thereof, the discharge orifices in said intermediate conduit being angularly displaced approximately 180° from the discharge orifices in said inner conduit;

baffle means disposed within said intermediate chamber in sealing engagement with the inner peripheral wall of said intermediate conduit and the outer peripheral wall of said inner conduit for dividing said chamber into a plurality of axially spaced subchambers; and

an elongated outer conduit on the outside of and ex-

tending along the length of said intermediate conduit and defining an outer steam receiving chamber in heat transfer relationship with said intermediate conduit, inlet and outlet couplings connected to said outer conduit and adapted for connection to a supply of steam so that flow of steam into and through said outer steam receiving chamber minimizes condensation of steam flowing within said intermediate steam receiving chamber.

9. A humidifier according to claim 8, wherein said intermediate chamber is divided into at least first and second axially spaced and isolated subchambers, one of said inner and intermediate conduits having a first set of spaced discharge orifices communicating with said first subchamber and a second set of spaced discharge orifices communicating with said second subchamber, the individual orifices of said first set having a flow area different from the flow area of the individual orifices of the second set.

10. A humidifier according to claim 9, wherein all of the orifices of said first set are of constant diameter, and wherein all of the orifices of said second set are of constant diameter, the orifices of said second set being of different diameter from the orifices of said first set.

11. A humidifier according to claim 10, wherein the other of said inner and intermediate conduits has a third set of spaced orifices formed therein and communicating with said first subchamber and a fourth set of spaced orifices formed therein and communicating with said second subchamber, the orifices of said third and fourth sets all being of a constant diameter.

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