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(54) MISTING APPARATUS WITH MOISTURE ELIMINATOR AND RELATED METHOD

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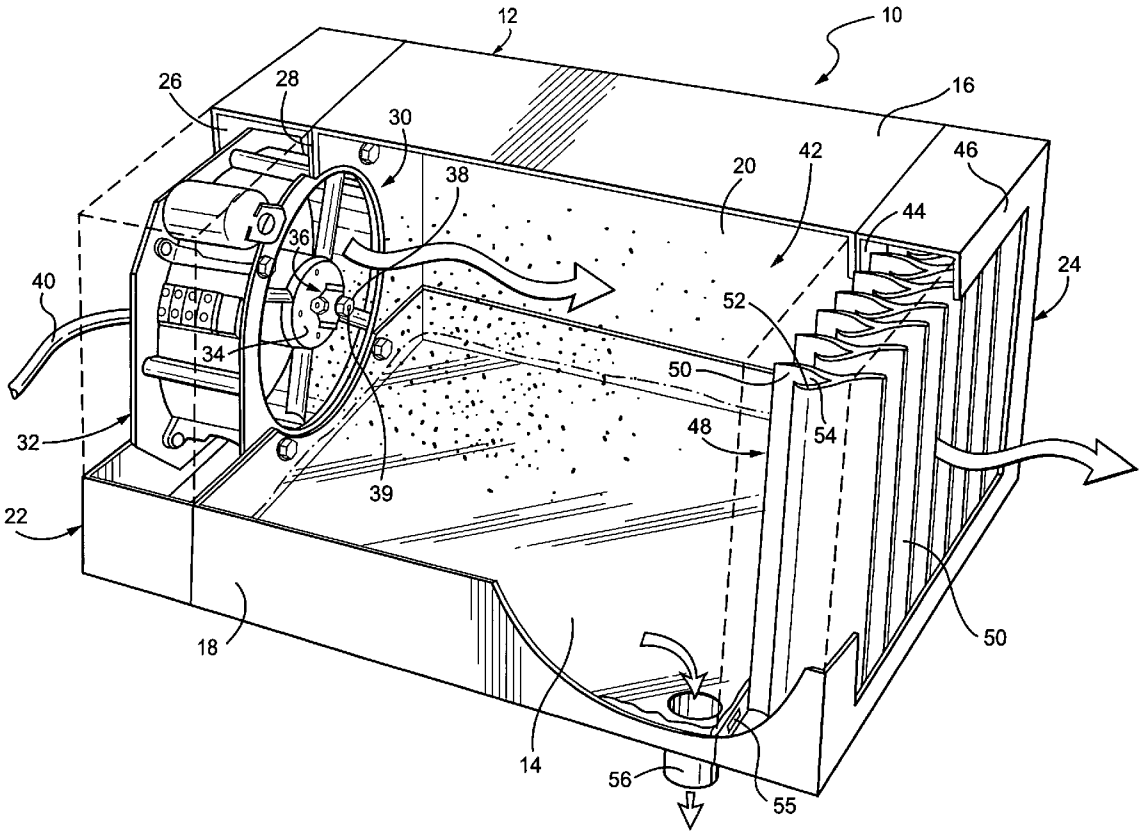
(57) ABSTRACT

Misting apparatus includes a housing defined by a bottom wall, a top wall, a pair of side walls and a pair of end wall assemblies; a plenum chamber within the housing; a fan mounted in one of the end wall assemblies for supplying air flow to the plenum chamber; at least one misting nozzle located proximate to an outlet side of the fan to thereby supply droplets of water into the air flow, and a moisture eliminator mounted in the other of the end wall assemblies. The moisture eliminator is shaped to remove unevaporated water droplets from the cooled air before the air exits the plenum chamber. A method of supplying cooling air to a space includes the steps of a) adding water droplets to a flow of air to thereby generate a flow of cooled air; b) removing unevaporated water droplets from the cooled air; and c) delivering the cooled air to the space.



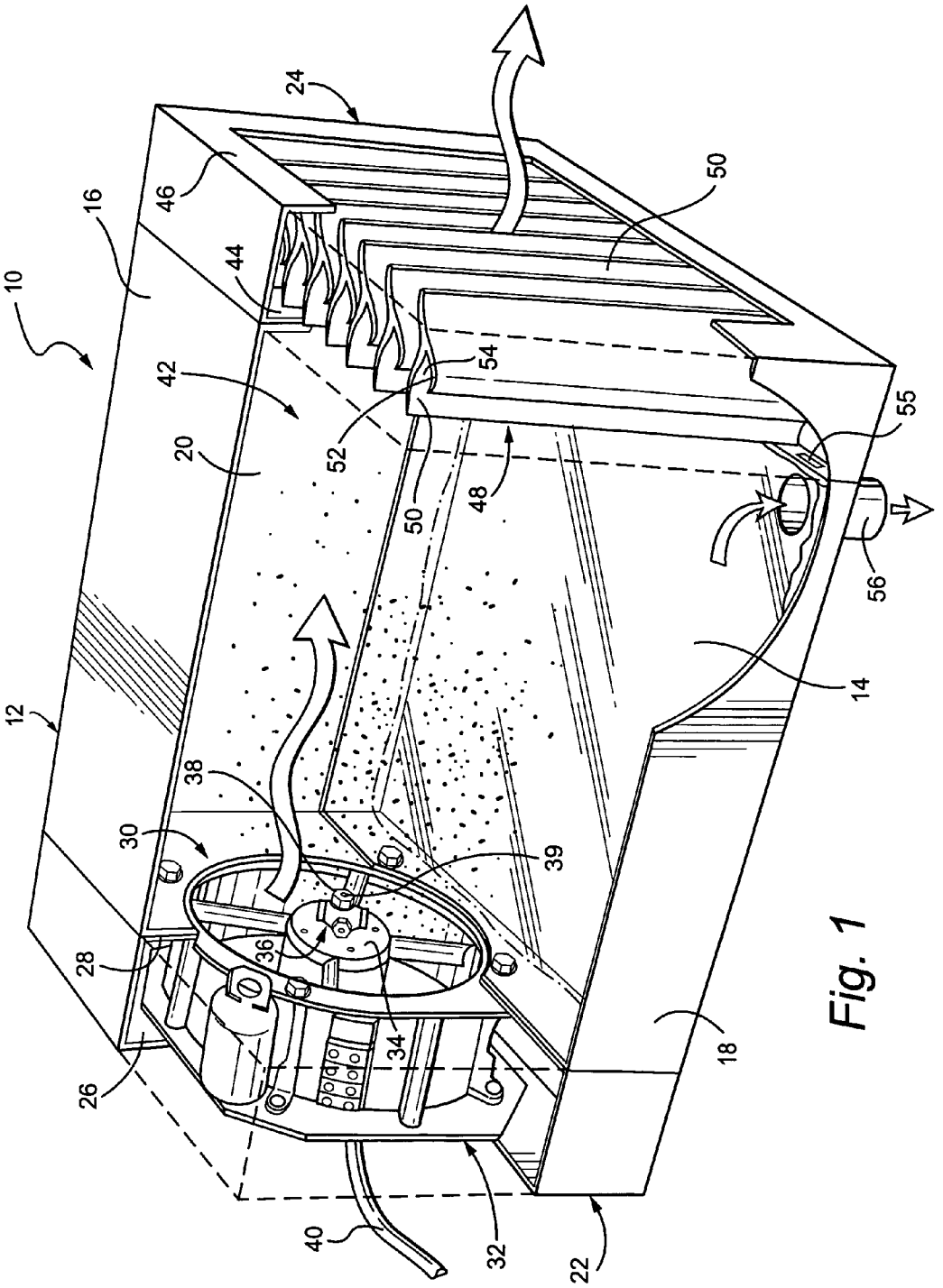

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Fig. 1

Fig. 2

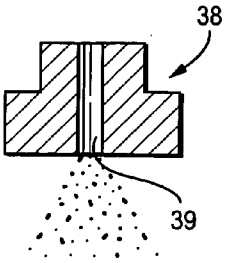


Fig. 3

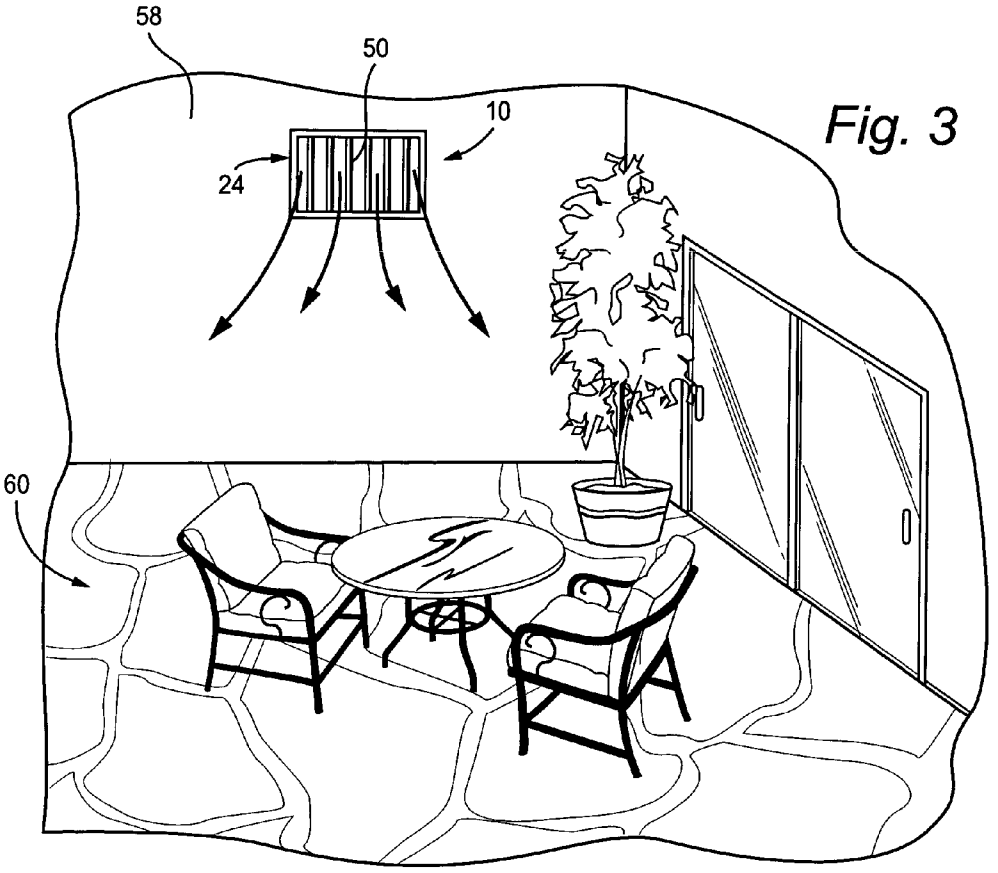
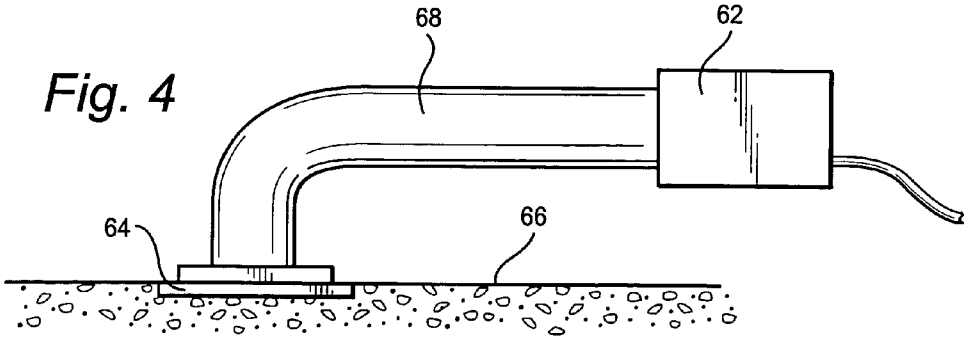


Fig. 4



MISTING APPARATUS WITH MOISTURE ELIMINATOR AND RELATED METHOD

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] There are many situations where it is desired to provide evaporative cooling in an area, or of people or other living beings (such as plants or animals) within the area. For that purpose, low pressure (under 100 psi), medium pressure (100 but under 200 psi), and high pressure (200+ psi) systems are commercially available. However, most such systems, while providing effective cooling, also add humidity to the air which in some cases is undesirable. Examples of current misting systems may be found in U.S. Pat. Nos. 5,628,273; 6,175,969 and 6,262,826. These systems are utilized in a marine environment and provide for evaporative cooling associated with watercraft. In some applications, however, it is desirable that the cooled air not have the higher humidity level generated by the use of misting nozzles that add water droplets to the air.

[0002] According to the present invention, a compact misting apparatus or unit, usable with or without additional ducting, not only creates a high pressure mist to reduce the temperature of air flowing through the unit, but also eliminates a significant portion of the moisture before the cooled air exits the unit. In an exemplary embodiment, the misting apparatus includes a housing having top and bottom walls, a pair of side walls and a pair of end wall assemblies that, together, define an interior plenum chamber. A fan and associated misting nozzles are mounted in one of the end wall assemblies and a moisture eliminator is mounted in the opposite end wall assembly such that air is drawn into the plenum chamber by the fan and cooled by the mist introduced by the misting nozzles (via latent heat of evaporation). As the cooled air flows through the moisture eliminator, unevaporated droplets are removed before the air flows into the space or area to be cooled.

[0003] At least one and preferably a plurality of misting nozzles are mounted in the center hub of the fan, at the outlet or downstream side of the fan, so that air flowing into the plenum chamber entrains the droplets of water emitted as a fine mist via the one or more nozzles.

[0004] The moisture eliminator in the opposite end wall assembly may comprise a plurality of generally vertically oriented vanes provided with individual profiles that are specially shaped to turn the air flow as it passes over and through the profiled surfaces. Since the unevaporated water have a higher mass than the air, the unevaporated droplets will impinge on the vane surfaces, forming a liquid film that is pushed along the vane surfaces into areas of low pressure located behind respective hook structures formed on the vanes. Here, the liquid film coalesces into larger droplets that drain via gravity onto the bottom wall of the plenum chamber. A drain in the bottom wall returns the water to a sump from which the water is recirculated to the misting nozzles.

[0005] A suitable pump supplies water at high pressure (typically between about 200 and 1000 psi) to the misting nozzles that are designed to emit droplets having a maximum cross sectional dimension of between about 5 and 100 microns.

[0006] Accordingly, in one aspect, the present invention relates to a misting apparatus comprising a housing defined by a bottom wall, a top wall, a pair of side walls and a pair of end wall assemblies; a plenum chamber within the housing; a fan mounted in one of the end wall assemblies for supplying air flow to the plenum chamber; at least one misting nozzle located proximate to an outlet side of the fan to thereby supply droplets of water into the air flow, the at least one misting nozzle connected to a source of water under pressure; and a moisture eliminator mounted in the other of the end wall assemblies, the moisture eliminator shaped to remove unevaporated droplets before the air flow exits the plenum chamber.

[0007] In another aspect, the present invention relates to a method of supplying cooled air to a space comprising a) adding water droplets to a flow of air to thereby generate a flow of cooled air; b) removing unevaporated water droplets from the cooled air; and c) delivering the cooled air to the space.

[0008] In still another aspect, the invention relates to a method of cooling an area comprising a) introducing water droplets having a size of from 5-100 microns into an airflow entering a plenum chamber to thereby cool the airflow; b) removing unevaporated water droplets from the airflow as the airflow exits the plenum chamber; and c) supplying cooled airflow to the area.

[0009] The invention will now be described in connection with the drawings identified below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** is a perspective view, partially cut away, illustrating a compact mating apparatus for cooling an area, with an integrated moisture eliminator in accordance with an exemplary embodiment of the invention;

[0011] **FIG. 2** is a cross-section of a misting nozzle appropriate for use with the apparatus illustrated in **FIG. 1**;

[0012] **FIG. 3** is a partial perspective view of one application for the apparatus shown in **FIG. 1**; and

[0013] **FIG. 4** is a schematic view of an apparatus as shown in **FIG. 1** with ducting added between the apparatus and a remote outlet for the cooled air.

DETAILED DESCRIPTION OF THE INVENTION

[0014] With reference to **FIGS. 1-3**, the misting apparatus **10** in accordance with an exemplary embodiment of the invention includes a box-like housing **12** that is made up of a bottom wall **14**, a top wall **16**, a pair of side walls **18** and **20**, and a pair of end wall assemblies **22** and **24**. The end wall assembly **22** includes axially spaced wall sections **26** and **28** between which is mounted a fan **30**. The assembly is secured to the housing top, bottom and side walls by any conventional means. The fan itself may be any suitable commercially available fan, for example, an 8 inch "Whisper Quiet Axial Marine Fan" available from Delta "T" Systems, Inc. of Jupiter, Fla. This fan generates flows to 607 CFM and is secured within its own flanged housing **32** of cast aluminum that is secured by any suitable means, such as bolts, to the axially spaced wall sections **26** and **28**, thus creating the end wall assembly **22**. The fan **30** includes a

center hub **34** to which is secured a nozzle assembly **36** that, in the exemplary embodiment, includes a plurality of misting nozzles that may be of the type sold by Fogco Systems, Ltd., of New Castle-on-Tyne, U.K., and that are preferably constructed of brass or steel. Each individual nozzle **38** may include one or more nozzle orifices **39** (not drawn to scale), each having a diameter of between about 0.2-0.5 mm. When supplied with water at a pressure of between about 200-1000 psi, the orifice(s) **39** of the nozzles **38** deliver a mist of water droplets having a maximum cross sectional dimension of between about 5-100 microns. This provides maximum flash evaporative cooling (the latent heat of evaporation of water is about 600 calories/gm), to reduce the temperature of the airflow in the plenum chamber by about 12-15° F.

[**0015**] Water is supplied to the misting nozzles **38** by means of a tube or conduit **40** that is connected to a pump (not shown). The pump per se is not part of this invention, and any suitable pump or other device for pressurizing liquid to a pressure of about 200 to 1000 psi may be utilized. For example, one suitable pressurizing pump is a Triplex Direct Drive Plunger Pump Model 2SF sold by Cat Pumps of Minneapolis, Minn. The mist emitted from the nozzles **38** is entrained into the airflow exiting the fan **30** in the direction of the flow arrow in **FIG. 1** in a direction from the end wall assembly **22** (the inlet end) towards the end wall assembly **24** (or outlet end). Thus, the mist laden air flows through a plenum chamber **42** within the housing **12** toward the end wall assembly **24**. End wall assembly **24** is also comprised of axially spaced wall sections **44**, **46** that form a frame component for the moisture eliminator assembly **48**. This assembly is also secured to the top, bottom and side walls by any conventional means, and comprises a plurality of generally vertically oriented vanes **50** that are each formed with a curved profile so that air flowing in the flow direction is caused to turn as it flows between the vanes.

[**0016**] Each vane **50** is formed with an integral hook portion **52** that creates a low pressure area **54** along the vertical length of the vanes. In operation, since the unevaporated mist or moisture droplets have a higher mass than air, they cannot change direction as quickly as air and, as the air flows through the vanes **50**, the moisture droplets impinge upon the surfaces of the vanes **50**, forming a liquid film that is driven by the air flow into the low pressure areas **54** between the hook portions **52** and vanes **50**. As water collects in these low pressure areas, it will coalesce and form droplets that drain by gravity through one or more slots **54** in the wall section **44**, onto the bottom wall **14** of the housing. The water will then flow through a drain **56** to a sump (not shown) from which water will be recycled to the misting nozzles **38** on the hub **34** of the fan **30**.

[**0017**] It will be appreciated that the apparatus as described may be located behind the wall of an interior space, with the end wall assembly **24** and moisture eliminator **48** located flush with the wall surface so that cooled relatively dry air will flow into the area where cooling is desired. One such example is shown in **FIG. 3** where the apparatus **10** is mounted behind an exterior wall **58**, with the end wall assembly **24** substantially flush with the outside surface of the wall **58**, such that cooled air is supplied to a patio or outside eating area **60** of, for example, a restaurant. Of course, the site location of the unit may be varied as desired.

[**0018**] **FIG. 4** illustrates, schematically, another embodiment where a misting unit **62** similar to unit **10** in **FIG. 1**, is located remote from a cool air supply vent or grill **64** mounted on a vertical wall **66**, with ducting **68** extending between the unit **62** and vent **64**. It will be understood that the moisture eliminator may be integrated with the unit **64** similar to the arrangement in **FIG. 1**, or it may be incorporated into the vent **64**.

[**0019**] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. Misting apparatus comprising:

a housing defined by a bottom wall, a top wall, a pair of side walls and a pair of end wall assemblies;

a plenum chamber within said housing;

a fan mounted in one of said end wall assemblies for supplying air flow to said plenum chamber;

at least one misting nozzle located proximate to an outlet side of said fan to thereby supply droplets of water into said air flow, said at least one misting nozzle connected to a source of water under pressure; and

a moisture eliminator mounted in the other of said end wall assemblies, said moisture eliminator shaped to remove unevaporated droplets before said air flow exits said plenum chamber.

2. The apparatus of claim 1 wherein said other of said end wall assemblies comprises a plurality of substantially vertically oriented vanes secured within a frame.

3. The apparatus of claim 2 wherein said vanes are profiled so that said air flow must change direction to exit the housing, thereby causing said unevaporated droplets to impinge on said vanes, and to collect on said bottom wall of said plenum chamber.

4. The apparatus of claim 3 wherein said bottom wall is fitted with a drain for transferring water collected on said bottom wall to a sump.

5. The apparatus of claim 1 wherein said fan includes a center hub and wherein said at least one nozzle is mounted in said center hub.

6. The apparatus of claim 1 wherein said at least one nozzle comprises a plurality of nozzles.

7. The apparatus of claim 6 wherein said fan includes a center hub and wherein said plurality of nozzles are mounted in said hub, each of said nozzles provided with at least one discharge orifice.

8. The apparatus of claim 1 wherein said source of water under pressure is adapted to deliver water to said at least one misting nozzle at between 200-1000 psi.

9. The apparatus of claim 7 wherein said at least one discharge orifice has a diameter of between about 0.2-0.5 mm.

10. A method of supplying cooled air to a space comprising:

a) adding water droplets to a flow of air to thereby generate a flow of cooled air;

b) removing unevaporated water droplets from the cooled air; and

c) delivering the cooled air to the space.

11. The method of claim 10 wherein said water droplets have cross-sectional dimensions of between 5 and 100 microns.

12. The method of claim 10 wherein step a) is carried out by locating one or more misting nozzles on an outlet side of a fan.

13. The method of claim 10 wherein step b) is carried out by directing the cooled air through a plurality of curved vanes such that the unevaporated water droplets collect on said vanes.

14. The method of claim 13 wherein said unevaporated water droplets coalesce into larger droplets that are collected and returned for use in step a).

15. The method of claim 10 wherein step a) is carried out by delivering water at a pressure of from 200-1000 psi to one or more misting nozzles.

16. A method of cooling an area comprising:

a) introducing water droplets having a size of from about 5-100 microns into an airflow entering a plenum chamber to thereby cool the airflow;

b) removing unevaporated water droplets from the airflow as the airflow exits the plenum chamber; and

c) supplying cooled airflow to the area.

17. The method of claim 16 wherein step a) is carried out by supplying water at a pressure of from about 200-1000 psi to one or more misting nozzles located on an outlet side of a fan.

18. The method of claim 16 wherein step b) is carried out by directing the airflow through a plurality of curved vanes mounted at an outlet end of said plenum chamber.

19. The method of claim 17 wherein step b) is carried out by directing the airflow through a plurality of curved vanes mounted at an outlet end of said plenum chamber.

20. The method of claim 16 wherein said plurality of vanes include surfaces shaped and arranged to catch said unevaporated water droplets in the airflow and to direct said unevaporated water droplets to a drain in said plenum chamber.

21. The method of claim 21 and further comprising:

d) recirculating the unevaporated water droplets removed in step b) for use in step a).

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