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Budike

(54) **BUILDING HEAT LOAD REDUCTION METHOD AND APPARATUS**

(76) Inventor: **Lothar Budike**, Vilanova, PA (US)

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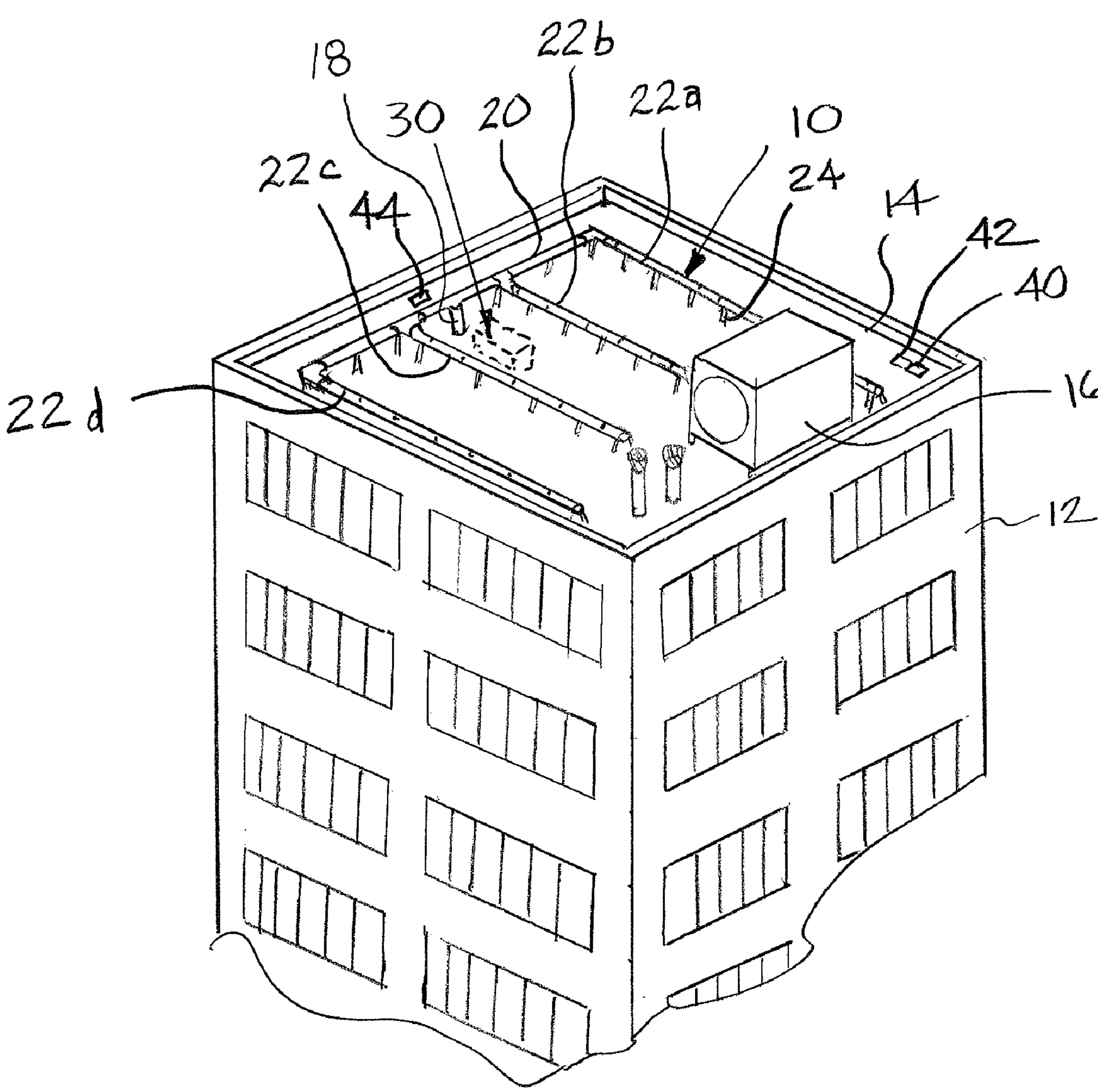
(52) **U.S. Cl.** **62/126**

(57) **ABSTRACT**

A building heat load reduction system is provided having a series of spray nozzles located on a building roof that are connected to a cooling liquid supply. A temperature sensor on the roof is connected to a controller and, depending upon the heat on the roof, supplies liquid coolant to the spray nozzles which sprays the liquid coolant onto the roof. A moisture sensor on the roof or in the roof drain provides a signal to the controller so that once the top of the roof is wet, the sprinkler is shut down so that excess water is not wasted. A liquid coolant/surfactant mixing system is provided which mixes a surfactant with the cooling liquid to provide enhanced cooling. The surfactant causes the liquid coolant being sprayed to have a smaller droplet size which creates a relatively higher specific surface area for the water droplets.



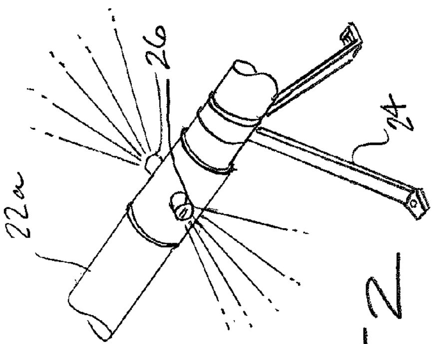


FIG. 2

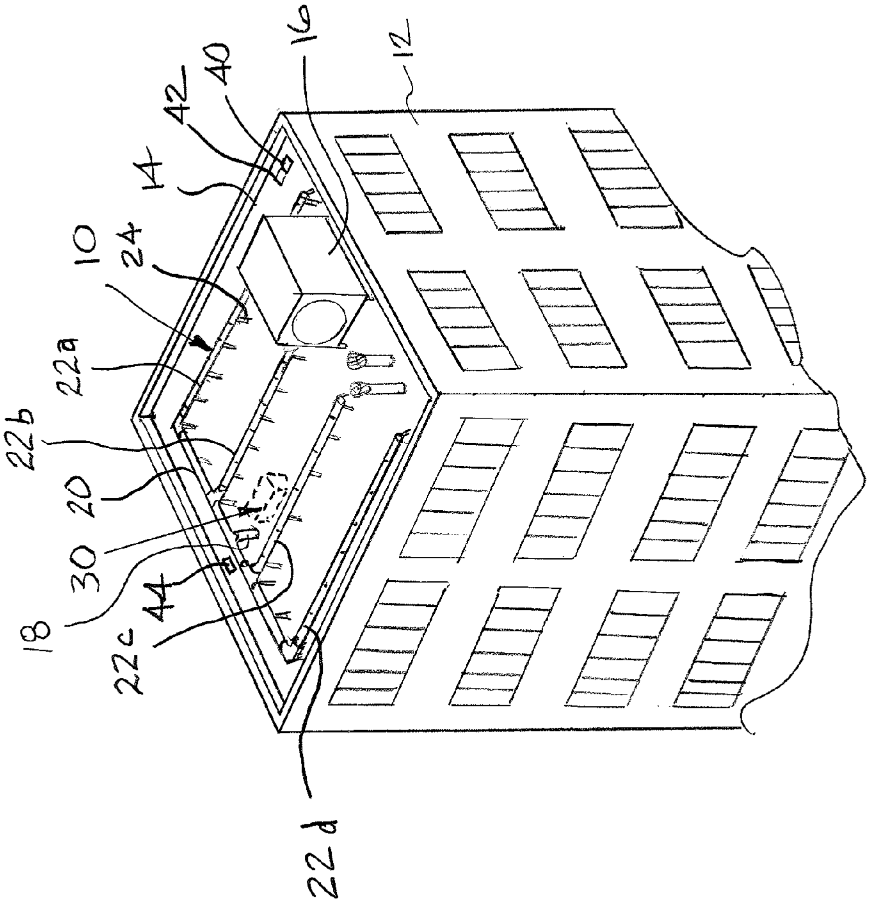


FIG. 1

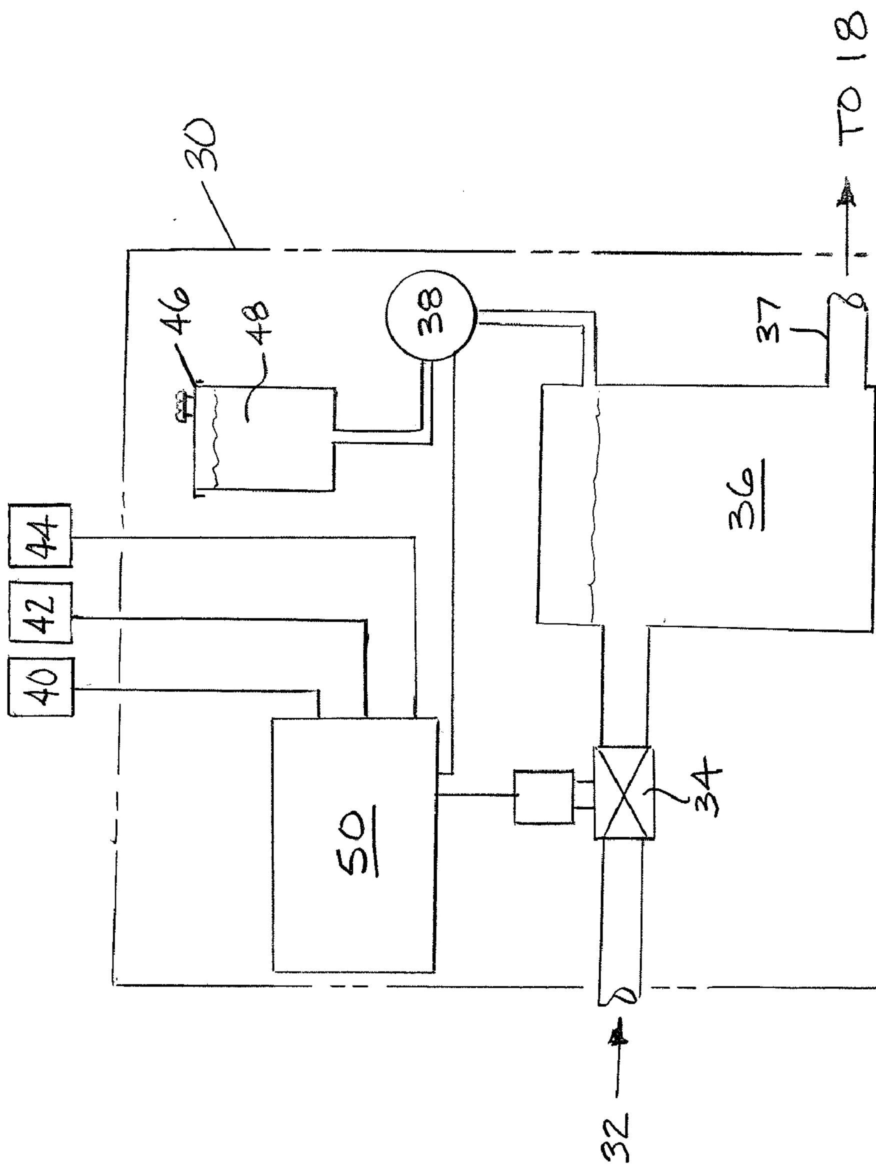


FIG. 3

BUILDING HEAT LOAD REDUCTION METHOD AND APPARATUS

CROSS-REFERENCES TO RELATED APPLICATIONS (if any)

[0001] This is a non-provisional application claiming priority of the provisional application 61/431,995 filed Jan. 12, 2011.

STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY-SPONSORED RESEARCH AND DEVELOPMENT (IF ANY)

[0002] None

BACKGROUND

[0003] Heating and cooling costs for commercial buildings are a substantial expense. In order to use less energy, it would be desirable to find more efficient ways of heating and/or cooling buildings so that these costs and energy consumption are reduced. During the summer months, cooling requirements for buildings become very high due to the higher heat load. Typically, additional cooling units or chillers are brought on line in the summer months to cool buildings. In certain areas energy supply cannot keep up with the demand for energy used in cooling buildings resulting in rolling brown outs or black outs. This is especially true in the afternoon when the heat load from the sun is the highest, depending upon the building orientation and construction.

[0004] The problem of cooling buildings is also more complex due to the varying heat load by floor based on usage and occupancy. Additionally, the higher floors of a building require more cooling as the heat within the building structure rises toward the top of the building. So at the building roof, in addition to heat from inside the building rising, there is generally additional heat from direct sunlight making it more difficult for the building to discharge heat.

[0005] It would be desirable to provide a cost efficient method for reducing the heat load in a building and therefore reduce the amount of cooling required.

SUMMARY

[0006] Briefly stated, the present invention provides a building heat load reduction system. The system comprises a series of sprinklers located on a building roof that are connected to a cooling liquid supply. A temperature sensor on the roof is connected to a controller and, depending upon the heat on the roof, supplies liquid coolant to the sprinkler system which sprays the liquid coolant onto the roof. A moisture sensor on the roof or in the roof drain provides a signal to the controller so that once the top of the roof is wet, the sprinkler is shut down so that excess liquid coolant is not wasted. Additionally, a liquid coolant/surfactant mixing system is provided which mixes a surfactant with the cooling liquid to provide enhanced cooling. The surfactant concentration can be varied based on temperature. The surfactant causes the liquid coolant being sprayed to have a smaller droplet size which creates a relatively higher specific surface area for the water droplets. This provides more even coating and allows for better heat transfer from the building roof due to more rapid vaporization resulting in enhanced cooling.

[0007] In another aspect, a sensor is provided to detect a concentration of residual surfactant located on the roof surface. The sensor signals the controller to reduce the amount of surfactant being mixed with the cooling liquid prior to spraying based on the residual amount of surfactant located on the roof surface.

[0008] In another aspect, the invention provides a method for reducing the energy required for cooling a building. The method includes spraying a liquid coolant on the roof of a building and sensing when liquid reaches the building roof drain such that the spray of cooling liquid is stopped so that additional cooling liquid is not wasted. Further, a surfactant supply and mixing tank is connected to the cooling liquid supply and a surfactant is preferably mixed with the cooling liquid, depending upon a roof temperature of the building, in order to enhance heat transfer from the building through more rapid vaporization of the cooling liquid due to the smaller droplet size and higher specific surface area based on the surfactant concentration.

[0009] In another aspect, the method further includes sensing residual surfactant on the roof surface activated by the cooling liquid and signaling the controller so that a concentration of the surfactant added to the cooling liquid prior to being sprayed onto the building roof is reduced.

[0010] Preferably, the cooling liquid is water from the building water supply.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The foregoing summary and the detailed description which follows will be best understood when read in conjunction with the attached drawings. In the drawings:

[0012] FIG. **1** is a perspective view showing a portion of a building including the roof with a building heat load reduction system according to the invention located on the roof.

[0013] FIG. **2** is an enlarged view of a portion of the sprinkler pipe including spray nozzles for delivering a cooling liquid to the roof.

[0014] FIG. **3** is a schematic diagram showing the cooling liquid mixing and supply system used in connection with the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Certain terminology is used in the following description for convenience only and is not limiting. The words "right," "left," "top," and "bottom" designate directions in the drawings to which reference is made. The words "a" and "one" are defined as including one or more of the referenced item unless specifically stated otherwise. This terminology includes the words above specifically mentioned, derivatives thereof, and words of similar import.

[0016] Referring to FIG. **1**, a building heat load reduction system **10** is schematically illustrated on the roof **14** of a building **12**. Such roofs **14** typically including HVAC units **16** as well as other building mechanical systems which are arranged in various configurations. Accordingly, the illustration shown is meant to be exemplary and the system **10** in accordance with the invention can be used with other roof top configurations.

[0017] The roof top portion of the building heat load reduction system includes the cooling liquid supply pipe **18** which extends up from inside the building **12** where it is connected to a cooling liquid mixing and supply system **30**, shown schematically in FIG. **1** and explained in further detail below in connection with FIG. **3**. The cooling liquid supply pipe **18** is connected to a header pipe **20** which leads to sprinkler pipes

22*a*, 22*b*, 22*c*, 22*d* which are supported on the roof **14** via supports **24** as shown in FIG. **2**. The supports **24** can be A-frames as shown or any other suitable configuration which keeps the header piper **20** and sprinkler pipes **22***a-d* off the roofs surface. Spray nozzles **26** are connected to the sprinkler pipes **22***a-d* and are arranged to provide a pattern for generally full coverage of coolant liquid onto the surface of the roof **14**. In the preferred embodiment, the cooling liquid consists primarily of water and accordingly, the spray pattern of the nozzles **26** is preferably arranged to cover substantially all of the roof top. While one configuration of the header piper **20** and sprinkler pipes **22***a-d* is shown, those skilled in the art will appreciate that various other configurations can be utilized depending upon the roof top configuration. Further, it is also possible to provide the header pipe **20** and/or the sprinkler pipes **22***a-d* directly on the roof top without the supports **24** and the position and angle of the spray nozzles **26** can be adjusted to still provide full coverage of the roof **14**, depending on the specific roof construction and drainage requirements.

[0018] Referring to FIG. **3**, the cooling liquid mixing and supply system **30** is shown in detail. The cooling liquid mixing and supply system **30** is preferably connected to a building water source **32**; however, it is possible to connect it to a source of other type of cooling liquid. In the preferred embodiment, the building water source **32** provides pressurized water to a control valve **34** which leads to a mixing tank **36**. The mixing tank **36** can be an in-line mixing arrangement which uses internal fins and a venturi effect to mix in a surfactant or can be a larger tank with mixing implements located in the tank, if desired. The tank outlet **37** of the mixing tank **36** and leads to the cooling liquid supply pipe **18** that extends to the roof **14** of the building **12**.

[0019] A surfactant supply tank **46** is also provided and is connected to the mixing tank **36** by a surfactant supply line. A pump **38** is located along the surfactant supply line and is connected to a controller **50** which controls the pump **38** in order to provide a desired amount of surfactant **48** from the surfactant supply tank **46** to the mixing tank **36**. The controller **50** is also connected to the control valve **34**.

[0020] A cooling liquid sensor **40** is located on the roof **14** or in a roof top drain and is connected to the controller **50**. A salinity/surfactant sensor is also located on the roof **14** and is connected to the controller **50**. Additionally, a temperature sensor **44** is located on the roof **14** and is connected to the controller **50**. The controller **50** is preferably a PLC or other computer implemented programmable control.

[0021] In use, when the temperature on the roof **14** rises to a predetermined level, the temperature sensor **44** signals the controller **50** which opens the valve **34** such that pressurized water from the building water source **32** is directed to the mixing tank **36**. Depending upon the temperature, the pump **38** is activated in order to mix a predetermined amount of surfactant **48** into the mixing tank **36** with the water from the building water source **32**. The water/surfactant mixture is delivered via the tank outlet **37** and the cooling liquid supply pipe **18** to the roof top sprinkler system via the header pipe **20** and sprinkler pipes **22***a-d* where it is sprayed via the nozzles **26** onto the roof **14**. Depending upon the temperature, the controller **50** varies the amount of surfactant that is mixed with the water. The specific amount of surfactant will vary depending on the surfactant utilized. The surfactant mixed with the water results in the spray from the spray nozzles **26** having a smaller droplet size discharged onto the roof **14**. The smaller droplets of cooling liquid can absorb heat more rapidly due to the larger specific surface area of the droplets. This promotes heat transfer and more rapid vaporization of the cooling liquid. The water sensor **40** located on the roof **14** or in a roof top drain senses the water spray and determines if too much cooling liquid is being sprayed onto the roof and is, for example, running down the drain. The sensor **40** can be a volumetric flow sensor or a float sensor or any other suitable type of sensor which determines if a sufficient amount of cooling liquid is on the roof surface or whether cooling liquid is traveling down the roof drain and signals the controller **50** to close the valve **34** so that additional cooling liquid is not sprayed on to the roof **14**. The heat from the building **12** is transferred to the cooling liquid droplets sprayed onto the roof **14** which vaporize removing heat from the roof **14** and reducing the heat load on the building **12**.

[0022] Various types of surfactants may be utilized in connection with the present invention. It is believed that Ecosurf-SH™ or Ecosurf-EH™, which are available from Dow Chemical may be suitable. It is also possible that other types of non-ionic, anionic or cationic surfactants could be utilized.

[0023] To the extent that the heat removal from the building causes the water to evaporate, this results in residual surfactant **14** being left on the roof **14**. The residual surfactant can be reactivated via additional water sprayed from the nozzles **26** and reduce the amount of additional surfactant which must be mixed with the water delivered from the building water source **32** into the mixing tank **36**. The salinity/surfactant sensor **42** located on the roof **14** can detect the concentration of the surfactant in water located on the roof **14** once the roof **14** has been re-wetted. This can help reduce the amount of additional surfactant required as well as control the related costs.

[0024] The water mixing and supply system **30** can be cycled on and off based on the temperature sensor **44** as well as the cooling liquid sensor **40** on the roof **14** and/or in the roof drain.

[0025] The invention thus provides an economical augmentation to building cooling in a simple, cost effective matter.

[0026] While the preferred embodiments of the invention have been described in detail above, the invention is not limited to the specific embodiments described above, which should be considered as merely exemplary. Further modifications and extensions of the present invention may be developed, and all such modifications are deemed to be within the scope of the present invention as defined by the appended claims.

1. A building heat load reduction system, comprising:

a series of spray nozzles located on a building roof that are connected to a cooling liquid supply;

a control valve connected between the cooling liquid supply and the spray nozzles;

a temperature sensor on the roof;

a controller, the temperature sensor and the control valve being connected to the controller such that depending upon a temperature of the roof, the controller opens the control valve to supply liquid coolant to the spray nozzles which spray the liquid coolant onto the roof;

a liquid sensor on the roof or in a roof drain and connected to the controller to provide a signal to the controller so that once a predetermined amount of cooling liquid is on the roof, the controller closes the control valve.

2. The building heat load reduction system according to claim **1**, further comprising a liquid coolant/surfactant mixing system located between the control valve and the spray nozzles that mixes a surfactant with the cooling liquid to provide enhanced cooling.

3. The building heat load reduction system according to claim **1**, further comprising where said liquid coolant is water.

4. The building heat load reduction system according to claim **1**, further comprising where said liquid coolant is a mixture of water and one or more surfactant.

5. The building heat load reduction system according to claim **1**, further comprising having a salinity/surfactant sensor located on the roof to detect the concentration of the surfactant in water located on the roof once the roof has been re-wetted.

6. The building heat load reduction system according to claim **5**, further comprising having the residual surfactant be reactivated by the additional liquid sprayed from the spray nozzles.

7. The building heat load reduction system according to claim **2**, further comprising having with the water delivered from the building water source into said mixing system.

8. The building heat load reduction system according to claim **2**, further comprising having said mixing system being a mixing tank.

9. The building heat load reduction system according to claim **8**, further comprising having said mixing tank being an in-line mixing arrangement which uses internal fins and a venturi effect.

10. The building heat load reduction system according to claim **8**, further comprising having said mixing tank having mixing implements located in the tank.

11. The building heat load reduction system according to claim **8**, further comprising having a tank outlet from the mixing tank that leads to the cooling liquid supply pipe.

12. The building heat load reduction system according to claim **8**, further comprising having a surfactant supply tank connected to the mixing tank by a surfactant supply line.

13. The building heat load reduction system according to claim **12**, further comprising having a pump located along the surfactant supply line and connected to the controller.

14. The building heat load reduction system according to claim **13**, further comprising having the controller controlling the pump to provide a desired amount of surfactant from the surfactant supply tank to the mixing tank.

15. The building heat load reduction system according to claim **1**, further comprising having the liquid sensor being a volumetric flow sensor.

16. The building heat load reduction system according to claim **1**, further comprising having the liquid sensor being a float sensor.

17. The building heat load reduction system according to claim **1**, further comprising having the spray nozzles and the cooling liquid supply being supported by supports.

18. The building heat load reduction system according to claim **17**, further comprising having said supports being A-frames.

19. The building heat load reduction system according to claim **1**, further comprising having the spray nozzles arranged in a pattern that fully covers the roof with said coolant.

20. The building heat load reduction system according to claim **1**, further comprising having the heat from the building transferred to the cooling liquid droplets sprayed onto the roof causing said liquid droplets to vaporize removing heat from the roof and reducing the heat load on the building.

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