Feb. 24, 1970 A. YURDIN 3,497,453

METHOD AND APPARATUS FOR PROTECTION OF POWER HUMIDIFIER

Filed July 25, 1967

FIG. 1.

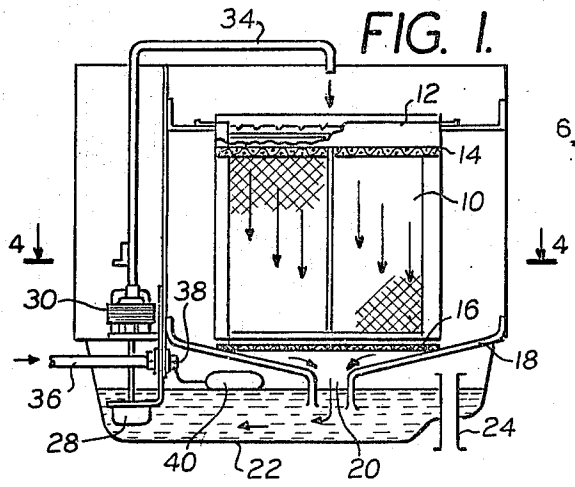


FIG. 5.

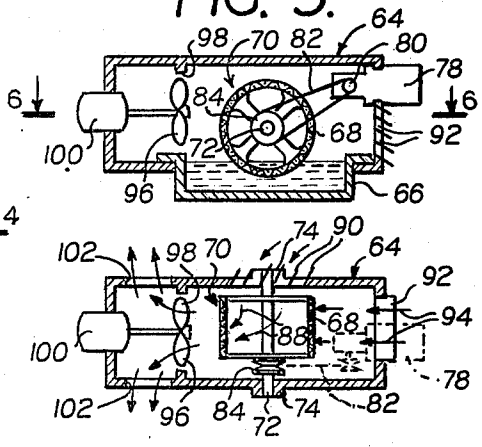


FIG. 2.

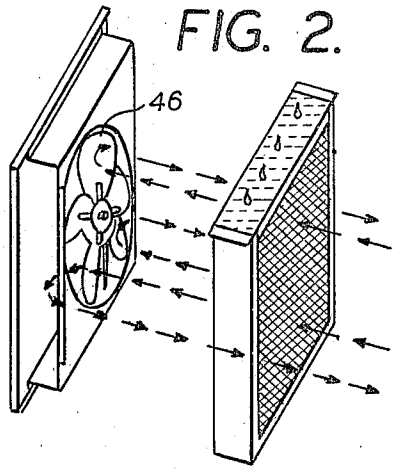


FIG. 3.

FIG. 6.

FIG. 4.

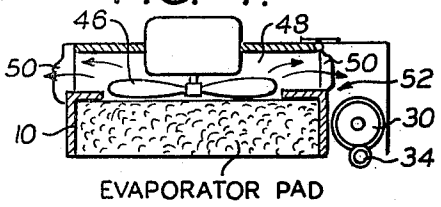


FIG. 7.

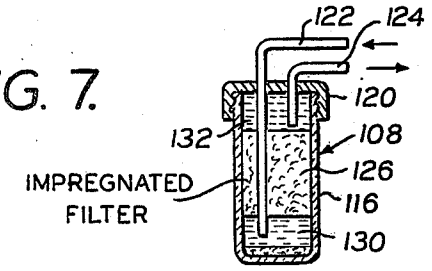


FIG. 8.

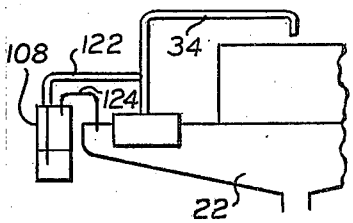
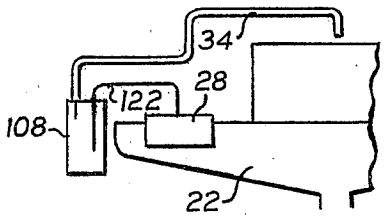


FIG. 9.



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3,497,453

METHOD AND APPARATUS FOR PROTECTION OF POWER HUMIDIFIER

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Int. Cl. C02b 1/22
U.S. Cl. 210—58 15 Claims

ABSTRACT OF THE DISCLOSURE

This specification discloses a method and apparatus for preventing the burning out of motors on power humidifiers and the clogging of the evaporator pads as the result of mineral deposits inside the recirculating pumps and in the interstices of the evaporator pads. Where hard water is likely to cause these results, this invention recirculates with the water in the humidifier chelating and coating agents that keep minerals, which crystallize in the water, free-flowing; and that coat the particles. Filters remove the coated particles from the closed system to limit the viscosity of the recirculating mixture. In the preferred constructions, there are several different arrangements of apparatus for filtering either the full flow or a by-passed flow, the latter permitting continued operation of the humidifier even though the filter is so filled with mineral deposits as to interfere with further flow of water through the filter.

BRIEF DESCRIPTION OF THE INVENTION

An efficient and popular type of power humidifier has a motor-driven pump that delivers water from a sump to an evaporator pad through which air is moved by a fan. Excess water drops from the pad back into the sump and is recirculated by the pump. In hard-water localities, where evaporation of water increases the concentration of minerals above the saturation point, the minerals coat the inside of the circulating pump and clog the interstices of the evaporator pad in less than one season of operation.

The building of the coating in the pump causes increased friction in the pump and often burns out the motor. The clogging of the evaporator pad reduces the efficiency of the humidifier, and pads have to be replaced after very short periods of use.

This invention prevents coating of the inside of pumps and prevents buildup of mineral deposits in the evaporator pad by keeping the minerals that crystallize from the water in a free-flowing condition. In the preferred embodiment of the invention, the free-flowing crystals are caught in filters so as to prevent a buildup of the viscosity of the recirculating mixture of water and suspended solids. This is done by circulating chelating and suspending agents simultaneously with the water through the humidifier circuit.

Although chelating agents for keeping crystals in suspension in a mother liquor are known and have been used in certain chemical processes, they have not been used in methods for protecting the pump and evaporator pad of a power humidifier.

The invention also includes several arrangements of apparatus for filtering either the full stream or a by-passed stream of the recirculating mixture of water and suspended solids. Apparatus for full stream filters is somewhat simpler in construction, but the use of a by-pass system has the advantage that even though the apparatus does not get adequate maintenance care and the filter becomes clogged, the humidifier can continue to operate though at decreasing efficiency.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

DETAILED DESCRIPTION OF THE DRAWING

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views:

FIGURE 1 is a diagrammatic sectional view through a power humidifier having a pump for supplying water to an evaporator pad;

FIG. 2 is a diagrammatic exploded view of a portion of the apparatus in the humidifier of FIGURE 1;

FIGURE 3 is an isometric view of one of the filters shown in FIGURE 2;

FIGURE 4 is a sectional view on the line 4—4 of FIGURE 1;

FIGURE 5 is a diagrammatic sectional view showing another type of power humidifier;

FIGURE 6 is a sectional view taken on the line 6—6 of FIGURE 5;

FIGURE 7 is a sectional view through a different type of filter from those shown in FIGURES 1 and 2; and

FIGURES 8 and 9 are diagrammatic piping diagrams showing the way in which the filter of FIGURE 7 can be used as either a full-flow or by-pass flow filter with the humidifier shown in FIGURE 1.

DETAILED DESCRIPTION OF THE INVENTION

The humidifer shown in FIGURES 1–4 includes an evaporator pad **10** to which water is supplied from a tray **12** located on top of the pad **10**. The tray **12** has openings in its bottom through which water runs down into the evaporator pad **10**. In the construction illustrated there is a filter **14** located between the tray **12** and the pad **10**. There is another filter **16** under the evaporator pad **10** and a dished baffle **18** with a center outlet **20** catches all of the excess water that runs through the pad **10**. A sump or water reservoir **22** is located under the baffle **18** and water runs through the center outlet **20** into the reservoir **22**. The reservoir has an overflow **24**.

Water which runs into the reservoir **22** from the outlet **20** is recirculated by a pump **28** driven by a motor **30**.

The discharge from the pump **28** is connected with tubing **34** which leads to the top of the humidifier and which discharges into the tray **12**. Since substantial quantities of water are lost by evaporation, it is necessary to supply makeup water. This is done by a water supply pipe **36** having a valve **38** operated by a float **40** in the reservoir **22**.

When the water level in the reservoir **22** drops below a given level, the float **40** drops and opens the valve **38**. As the water level rises, the float **40** also rises and closes the valve **38**. So long as the valve **38** is operated by the float **40**, the level of water in the reservoir never reaches the height of the overflow **24**; but in the event of improper operation of the valve **38**, the overflow of water through the overflow **24** provides a warning that the humidifier needs attention.

There is a fan **46** behind the evaporator pad **10** and this fan is driven in a direction to draw air through the pad. In the construction shown in FIGURE 4, the humidified air is discharged from a chamber **48** behind the fan through louvres **50** in the wall of a housing **52** of the humidifier.

In order to prevent minerals from coating the inside of the pump, and the interstices of the evaporator pad **10**, chelating and supending agents are introduced into the water which is recirculated in the humidifier. The agents which are preferably used for the pump are EDTA (ethylenediamine tetra-acetic acid) and quebracho. The che-

lating or sequestrating effect of the EDTA is to nullify the undesirable effects of metal ion impurities in the water. By combining with bi-, or tri-, polyvalent metal ions in the aqueous system, the EDTA forms complexes with the calcium, iron, copper, magnesium, tin and other metal ions present in hard water. The quebracho acts as a buffer and suspending agent by forming a protective coating around the solids which crystallize out of the water as the concentration exceeds the saturation point for the various solids.

This keeps the solids free-flowing as suspended in the water and prevents the coating of the inside of the pump and the interstices of the evaporator pad. However, the evaporator pad, if the interstices are small enough, may become clogged by filtering out the suspended solids. To prevent this, and to limit the viscosity of the recirculating mixture, the filters **14** and **16** are put at the top and bottom of the evaporator pad. Either of these filters **14** or **16** can be used alone. The filters **14** and **16** are replaced from time to time, and the period of operation before replacement depends, of course, upon the hardness of the water and the quantity of water evaporated by the humidifier.

In the preferred embodiment of the invention, the EDTA and quebracho (or its equivalent) are not used alone. Benzotriazole in a small amount is used as an inhibitor to prevent the EDTA from causing deterioration of any copper or aluminum of the humidifier. Better results are obtained by using a dispersing agent in the mixture and it is also desirable to include a rust inhibitor. The preferred mixture of chemical reagents includes also a quaternary ammonium compound for algae control.

When the formulation is supplied as a tablet, a binder is included in the formulation to hold the tablet together. The preferred formulation, in addition to the chelating or sequestering agent and the buffer referred to above, includes sodium nitrite as the rust inhibitor and a polyelectrolyte (Disperse A–6) as the dispersing agent. Benzotriazole is used as the inhibitor for the EDTA against damage to copper and aulminum. Magnesium stearate may be used as the binder for the tablet.

An illustrative formula which gives very good results contains the following proportions of ingredients by weight: 50% EDTA; 35% quebracho; 8½% sodium nitrite; 3½% Disperse A–6; 1% benzotriazole; .5% quaternary ammonium compound; and 1½% magnesium stearate.

Although the preferred formulation obtains remarkable results, some changes in the proportions can be made without unduly restricting the results obtained. For example the amount of EDTA can be varied between about 45 to 70%. The quebracho can be varied between about 25 to 40%.

The amount of the rust inhibitor can be varied between about 5 to 10%; the dispersing agent between about 3 to 5%. The benzotriazole can be varied from about .5 to 1.5%; and the algae control from about .25 to 1%.

Substitutions can be made for the different active ingredients. In the place of the EDTA (which is preferably used in the form of a tetrasodium salt), nitriloacetic acid trisodium salt monohydrate can be used. Tannic acid can be used in place or the quebracho; and sodium benzoate can be substituted for the sodium nitrite.

In place of benzotriazole, sodium gluconate can be used, or sodium silicate. Tributyl tin chloride is a substitute for the algae control. Various substitutes can be used for the binder such as calcium stearate with the necessary mold release, for example, hydrogenated cocoa oil.

The successful operation of the invention for protecting a power humidifier from damage by hard water and particularly for protecting the motor that drives the pump, depends upon there always being sufficient quantity of the formulation in the circulating system. Since the most important ingredients of the formulation are used up as additional minerals are precipitated from the water, it is necessary to add quantities of the formulation from time to time. The most convenient time to do this is when replacing a filter.

It is a feature of the invention that additional formulation is needed only when filters are replaced; and it is another feature of the invention that a service man can not forget to add the formulation in the right quantity whenever he replaces a filter.

In the preferred embodiment of this invention, the formulation is placed on the filter pad, either by impregnating it in the pad or assembling a tablet **58** (FIGURE 3) of the formulation with the filter by means of a tape **60**. When a service man finishes servicing a humidifier, he never has any doubt about whether he has replaced the filter because he has the old filter which has been replaced, but unless the formulation is a unit with the filter, it is very easy for a service man to forget to put the formulation in the humidifier and when he finishes the servicing he has no easy check whether he did or did not insert the new formulation.

An important reason for making a filter and the formulation as a unit, however, is to insure the right amount of formulation to protect the humidifier until it is necessary again to replace the filter. The amount of formulation used up in a humidifier depends upon the hardness of the water at each location and the filling up of the filter also depends upon the hardness of the water. This invention correlates the formulation with the capacity of the filter so that there is enough of the formulation with each filter to treat as much solid material from the water as will fill up that particular filter.

For a particular service organization in a particular territory, a filter may be considered filled up when its resistance to flow has increased 100% or some other specified amount beyond which the efficiency of the humidifier is considered unsatisfactory. Such specially made filter-formulation combinations have the advantage that they do not use unnecessary amounts of the formulation and are, therefore, more economical; but where it is desirable to have a standardized filter-formulation combination for all of the humidifier service organizations in a locality, the filter is supplied with a quantity of formulation sufficient to treat enough water to fill up the filter to the extent that any competent service man would consider it in need of replacement. For purposes of this invention, the formulation is enough to treat a quantity of water which will fill up the filter to a flow-resistance increase of at least 50% and preferably between 50% and 150%.

FIGURES 5 and 6 show a modified form of the invention in which the water is not recirculated by a pump. The humidifier includes a housing **64** having a reservoir **66** in which the water is contained. An evaporator pad **68** is wrapped around a drum **70** having an axle **72** which rotates in bearings **74** at opposite sides of the housing **64**.

The drum **70** is rotated by a motor **78** having reduction gearing **80** which drives a belt **82** that passes around a pulley **84** on the axle **72**.

The drum **70** has spokes with space between them through which air can enter the drum, as indicated by the arrows **88** in FIGURE 6. Air entering through one side of the housing **64** is deflected by louvres **90** toward an open end of the drum.

Other air enters the housing **64** through an end opening **92**, as indicated by the arrows **94**. The air flow is produced by a fan **96** located in a circular opening **98** in a partition across the inside of the housing **64**. The fan **96** is driven by a motor **100** supported from one end of the housing **64**. The humidified air exhausts from the housing **64** through openings **102** on opposite sides of the housing between the fan **96** and the end wall which supports the motor **100**.

The type of humidifier shown in FIGURES 5 and 6

is less desirable for use with this invention because such humidifiers do not include a pump for recirculating the liquid. To take full advantage of this invention it is necessary to add a pump **106** and a filter **108** located in a piping circuit **110** which constantly withdraws water from the reservoir **66** and circulates it through the filter **108**.

In the operation of the humidifier shown in FIGURES 5 and 6, the minerals precipitated on the drum **70** wash off into the reservoir **66**, into which the drum dips, because the chelating and coating agents prevent the minerals from caking on the evaporator pad **68** of the drum **70**.

FIGURE 7 is a sectional view through the filter **108**. This filter includes a container **116** with a cover, preferably a screwcap **120**. An inlet pipe **122** and an outlet pipe **124** extend through the cover **120**. There is an impregnated filter **126** located in the container **116** with some space for water both above and below the filter **126**. The inlet pipe **122** reaches down through the filter and discharges water into a space **130** below the filter **126**; and water which has passed upward through the filter is withdrawn from a space **132** through the outlet pipe **124**.

FIGURES 8 and 9 show two different ways in which the filter of FIGURE 7 can be used on the humidifier shown in FIGURE 1. In FIGURE 8, the pipe **122** is connected with the pipe **34** as a branch passage for the liquid discharged from the pump **28**. Some of the water passes through the pipe **34** to the evaporator pad in the humidifier and some of the water is by-passed through the pipe **122** to the filter **108**. From the filter **108** the water flows through the pipe **124** back to the reservoir **22**.

FIGURE 9 shows a construction which differs from FIGURE 8 in that all of the water from the pump **28** is pumped through the pipe **122** to the filter **108**. The entire discharge from the filter **108** passes through a pipe **34'** to the evaporator pad of the humidifier. The construction shown in FIGURE 9 has the advantage that all of the water supplied to the evaporator pad is filtered before recahing the pad. The construction shown in FIGURE 8 has the advantage that the humidifier can continue to operate, though inefficiently, even though the filter **108** becomes completely clogged.

It will be understood that the filter shown in FIGURE 7 is merely representative of means for filtering water which is circulated through the closed recirculating system of the humidifier, and that various other types of filters can be used. It is important, however, that the filters be of a type which can be easily replaced as necessary because power humidifiers evaporate large quantities of water and substantial amounts of mineral deposits are precipitated in areas where the water is hard.

The filter provides a collecting station for the particles which are precipitated from the water. By coating the particles, in accordance with this invention, their removal from the system is facilitated and it is important that they be removed because the continued recirculation of the particles, as additional particles precipitate, eventually builds up the viscosity of the circulating mixture and overloads the motor which drives the pump.

When the humidifier is equipped with an evaporator pad having interstices or flow through passages, the filter is preferably made with small interstices so as to filter out particles of a size sufficient to clog the evaporator pad. Thus the evaporator pad is protected from clogging by having hard mineral deposits form along the flow passages so as to reduce the cross section and eventually clog them; and it is protected by withdrawing from circulation free-flowing coated particles which are large enough to clog the flow passages of the evaporator pad.

The preferred embodiments of the invention have been illustrated and described and the invention is defined in the claims.

What is claimed is:

1. The method of protecting the pump and evaporator surface of a power humidifier from becoming coated with mineral deposits from hard water, which method comprises circulating and recirculating the water in the humidifier without substantial bleed-off of the circulating water from the humidifier, adding additional water to compensate the evaporation, recirculating with the water, and mixed therein, chelating and suspending agents that coat mineral particles which crystallize in the mixture whereby the crystallized minerals are kept free-flowing with the water, collecting mineral particles at a collecting station by passing the circulating water and entrained mineral particles through a filter that traps and holds the coated crystallized mineral particles, and periodically replacing the filter to remove said particles from the collecting station and from the humidifier as necessary to prevent coating of the pump and evaporator surface and to keep the viscosity of the circulating mixture below a given value.

2. The method described in claim **1** applied to a humidifier that has an evaporator pad, which method is characterized by collecting coated minerals in the humidifier and adjacent to the pad, on a filter having flow-through passages of smaller cross section than those of the evaporator pad, and removing accumulated particles by replacing the filter.

3. The method described in claim **2** characterized by distributing the water across the width of the pad at the top of the pad for flow into the pad by gravity, and locating the filter across the width of the pad at the top of the pad and in the path of the water flow to the pad.

4. The method described in claim **2** characterized by distributing the water across the width of the pad at the top of the pad for flow into the pad by gravity, flowing through the pad more water than can be evaporated during the time of passage of the water down through the pad, collecting coated particles of minerals at the bottom of the pad by locating the filter across the width of the pad at the bottom thereof.

5. The method described in claim **1** characterized by collecting the water for recirculation in a space from which it is withdrawn by power means for return to the evaporator surface, and circulating at least part of the water through a filter by the same power means that are used to return water from the collecting space to the evaporator surface.

6. The method described in claim **1** characterized by collecting the water for recirculation at a space from which it is withdrawn by power means for return to the evaporator surface, and by-passing part of the water from the collecting space through a filter to collect in the filter particles of minerals that flow to the filter in the water, and locating the filter in a space outside of the humidifier for more convenient access and replacement of filters.

7. The method described in claim **1** characterized by collecting the coated particles on a filter pad, replacing the chelating and suspending agents in the humidifier in proportion to their exhaustion from the system as coated particles are removed on filters, the proportional replacement being effected by securing to each new pad an amount of chelating and suspending agents sufficient to coat a quantity of mineral particles that will fill the filter pad to a condition that requires replacement.

8. The combination of a formulation for protecting the pump and evaporator surface of a power humidifier from becoming coated with mineral deposits from hard water, which formulation comprises a chelating or sequestering agent, and a buffer or suspending agent that coats the particles precipitated from the water, and a filter element having interstices that will collect the particles chelated and coated by the formulation, the formulation being secured to the filter and comprising a unit assembly with the filter for insertion into a humidifier as original equipment or as replacement for a filled-up filter, the formulation being correlated with the capacity of the filter whereby the formulation will coat enough

particles to fill up the filter to a predetermined state at which the filter is to be replaced.

9. The formulation described in claim **8** characterized by the quantity of the formulation being sufficient to treat enough water to fill up the filter to an increased flow resistance of at least 50%.

10. The formulation described in claim **9** characterized by the formulation comprising approximately 45 to 70% of a chelating agent, approximately 25–40% of buffer and suspending agent, approximately 5–10% of rust inhibitor, approximately 3–5% of an algae control and a binder.

11. The formulation described in claim **9** characterized by the formulation comprising 50% ethylenediamine tetraacetic acid, 35% quebracho, 8½% sodium nitrite, 3½% disperse (polyelectrolyte), 1% benzotriazole, .5% quaternary ammonium compound and 1½% magnesium stearate.

12. The formulation described in claim **9** characterized by the formulation including approximately 45–75% of chelating or sequestering agent from the group consisting of ethylenediamine tetraacetic acid and nitrilotriacetate acid trisodium salt monohydrate, approximately 25–40% of buffer and suspending agent from the group consisting of quebracho and tannic acid, approximately 5–10% of rust inhibitor from the group consisting of sodium nitrite and sodium benzoate, and approximately 3–5% of an algae control from the group consisting of a quaternary ammonium compound and tributyl trichloride.

13. The combination with a power humidifier having a pump and evaporator pad, the evaporator pad having interstices therein through which water is circulated and recirculated by the pump without substantial bleed-off of the circulating water from the humidifier, means for adding additional water to compensate for losses caused by evaporation of water from the pad, means for protecting the pump and evaporator pad from becoming coated with mineral deposits from hard water, including chelating and suspending agents in the recirculating system of the humidifier that coat mineral deposits which crystallize in the mixture whereby the crystallized minerals are kept free-flowing with the water, a collecting station including a filter through which the recirculated water passes, the filter having a fineness that is coordinated with the size of the interstices of the evaporator pad for removing coated particles which are entrained in the recirculating water and which are large enough to clog the interstices of the evaporator pad, the filter being removable from the humidifier system for periodic replacement to remove the particles from the collecting station and from the humidifier as necessary to prevent coating of the pump and evaporator pad and to keep the viscosity of the circulating mixture below a given value.

14. The combination described in claim **13** characterized by the filter being in series with the evaporator pad in the recirculation system and all of the water that passes through the evaporator pad passing through the filter.

15. The combination described in claim **13** characterized by the filter being located outside of the humidifier and being in a by-pass of a portion of the recirculation system but supplied with liquid from the humidifier by the same pump that recirculates the liquid to the evaporator pad.

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MICHAEL E. ROGERS, Primary Examiner

U.S. Cl. X.R.

210—60, 167, 506; 261—97