Nov. 4, 1969 W. R. STILES 3,476,673

HUMIDIFIER WITH ELECTROLYTIC PROTECTION

Filed Aug. 30, 1966

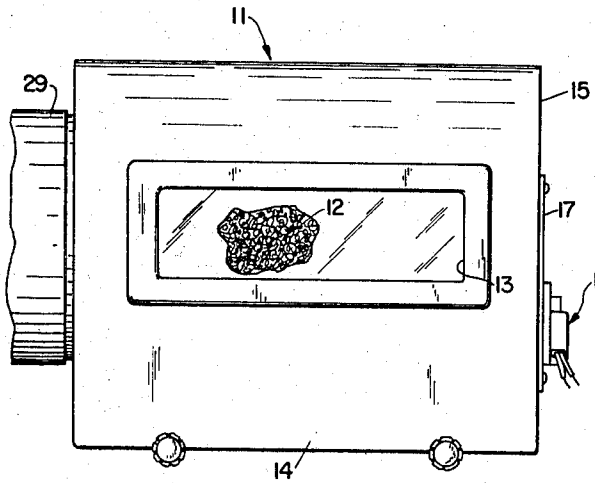


FIG. 1

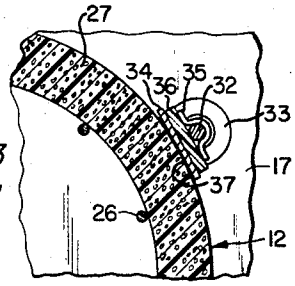


FIG. 3

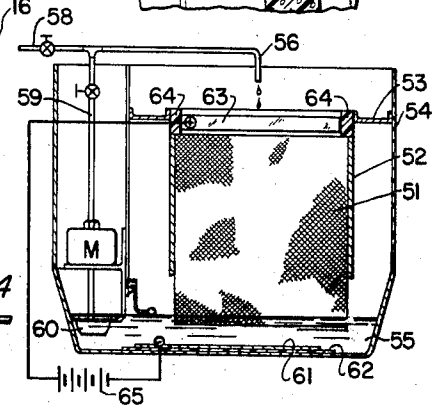


FIG. 4

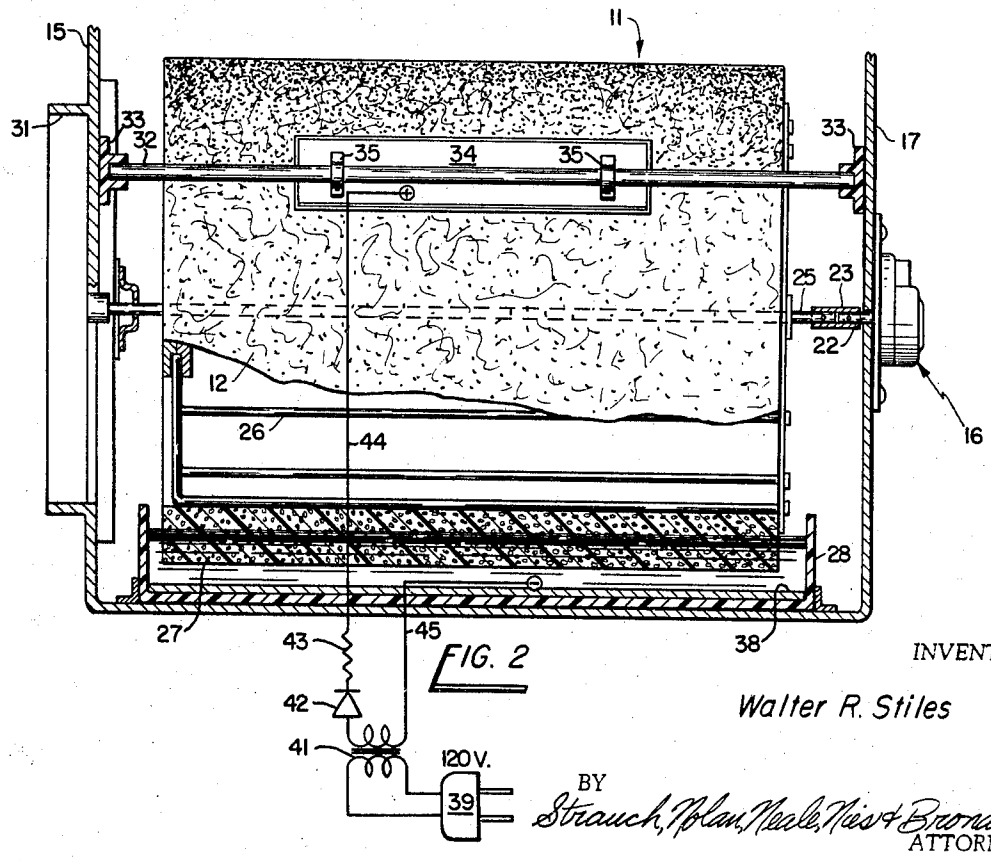


FIG. 2

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United States Patent Office 3,476,673 Patented Nov. 4, 1969

3,476,673

HUMIDIFIER WITH ELECTROLYTIC PROTECTION

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Filed Aug. 30, 1966, Ser. No. 576,075
Int. Cl. C23f *14/00*
U.S. Cl. 204—196 10 Claims

ABSTRACT OF THE DISCLOSURE

In a humidifier having a flexible porous evaporator pad having a lower portion immersed in a body of water, means for preventing the accumulation of solid deposits in the pores of the pad comprising means for applying a relatively small direct current electrical potential across a conductive element contacting a non-immersed region of the pad surface and a conductive element immersed in the body of water, said first named conductive element being positive.

This invention relates to humidifiers of the type wherein water is supplied to a body or pad of open pore plastic material such as foamed polyurethane that is adapted to collect water in its pores and then permit the collected water to be evaporated therefrom into a furnace hot air or like stream to be humidified, and is particularly concerned with an arrangement for protecting against the accumulation of solids deposits from the water within the pores during normal operation.

The invention in its preferred embodiment will be disclosed as applied to a rotary drum type humidifier of the type wherein a sleeve of open pore polyurethane or the like mounted on a supporting rotor is slowly rotated on a horizontal axis so that its lower sector continuously picks up water from a maintained level body of water and lifts the picked up water into the path of a furnace air stream for evaporation to humidify that air. The invention may be applied to stationary pad humidifiers as will also appear.

The water supply in such devices is the usual local water supply. All of these waters which are mainly so-called "hard" waters invariably contain insoluble mineral salts such as calcium carbonate which, during evaporation of the water, deposit and accumulate in the pores of the sleeve, so that in time the pores become clogged and the humidifier inefficient. Where the sleeve of the rotating drum type humidifier is of polyurethane which is elastic, it has been the practice to remove the sleeve from its support periodically, flex it to extract the dried powdered deposits from the pores and then replace it on the support. Besides the expense and labor required for this periodic service, this procedure has been found to present difficulties in that often the physical acts of removing or replacing the sleeve on the rotor have resulted in excess torque that stripped the gears driving the rotor.

Furthermore, one of the very objectionable conditions encountered in such humidifiers prior to the invention was that the porous sleeve or pad, upon continued use in hard water say for three or four months, became relatively hard and non-elastic due to the deposits and usually had to be damaged or destroyed in removing it from the rotor for cleaning and service. This required the purchase of a new sleeve, adding to the expense of maintenance. Using the invention, these porous sleeves or pads have greatly increased useful life.

The invention solves the foregoing difficulties by providing continuing protection against the accumulation of such salts and solids in the humidifier evaporator element pores, and this is the major object of the invention.

A further object of the invention is to provide novel electrolytic means for preventing the accumulation of solids deposits in the pores of moving or stationary humidifier pads.

Another object of the invention is to provide an improved humidifier wherein a small electrical potential is continuously applied to a water laden pad. Pursuant to this object the potential is provided by connecting opposite terminals of a small voltage direct current source (about 1.5 to 12 volts) to a conductive member at the pad surface in the air stream and a conductive member immersed in an adjacent body of water respectively.

Another object of the invention is to provide a humidifier of the type having a rotary drum surfaced with open pore plastic material which is rotated with its lower sector moving through a body of water and its upper sector moving through air to be humidified, wherein a small electrical potential is continuously applied between a region of the drum surface remote from the body of water and a conductive member contacting or disposed in the body of water. Pursuant to this object the potential is provided by connecting opposite terminal of a small voltage direct current source (about 1.5 to 12 volts) to the drum surface in the air stream and said conductive member respectively.

Further objects of the invention will appear as the description proceeds in connection with the appended claims and the annexed drawings wherein:

FIGURE 1 is a front elevation of a rotary element humidifier of the type for which the invention is especially suited;

FIGURE 2 is an enlarged section through the humidifier of FIGURE 1 showing the invention as incorporated therein for electrolytic prevention of pore clogging deposits on the rotary water pick-up drum;

FIGURE 3 is an enlarged fragmentary end view in section, showing a preferred manner of applying the positive side of the electrolytic control to the drum; and

FIGURE 4 diagrammatically shows the invention as applied to a stationary pad humidifier.

FIGURE 1 shows a humidifier **11** wherein a rotary water pick-up drum rotor **12** is suitably mounted on horizontal axis bearings and may be viewed in operation through window **13** of the openable cover **14** of housing **15**. An electric motor and reduction gear assembly **16** is mounted on side wall **17** of the housing.

The output shaft **22** of the motor and reduction gear assembly is axially aligned with and directly drive connected by a suitable coupling **23** to horizontal rotor shaft **25**. A wire cage **26** is fixed to shaft **25**, and the evaporator pad is a sleeve **27** of open pore electrically insulating when dry plastic material such as foamed polyurethane mounted on cage **26**. The lower sector of sleeve **27**, as shown, is disposed within a body of water suitably maintained at a constant level in a pan or the like **28**. Thus, as the drum **12** is rotated when the motor drives shaft **25**, water is constantly picked up by the lower sector of sleeve **27** and moved toward the upper part of the housing where it evaporates into air being forced through the housing, for example air entering from conduit **29** through housing aperture **31** and exiting at a suitable rear housing wall aperture (wall shown).

The foregoing general arrangement is currently known and used, and is described in the copending application of M. A. Powers, Ser. No. 181,567 filed Mar. 22, 1962, now abondoned. The humidifier rotor may also be formed as illustrated in the copending application on M. A. Powers, Ser. No. 327,026 filed Nov. 29, 1963, now U.S. Patent No. 3,285,586.

As shown in FIGURE 2, a fixed rod **32** extends horizontally within casing **15**. This may be one of the existing

metal casing frame rods, but in the invention rod **32** may be supported at opposite ends in electrically insulating brackets **33** fixed to the casing side walls. In any event rod **32** is rigid with casing **15**.

A relatively flat sheet metal plate **34** is fixed on rod **32** as by clamps **35**. Where rod **32** is metal and has its ends conductively secured to casing **15**, a block **36** of electrically insulating material is interposed between the back of plate **34** and rod **32**. In some structures, rod **32** may be non-conductive. In any event the conductive plate **34** is electrically insulated from casing **15**.

The flat face **37** of plate **34** which is preferably smooth polished stainless steel, aluminum or equivalent metal contacts the rotating surface of sleeve **27** substantially tangentially under slight pressure while offering little or no resistance to rotation. The water in the sleeve effectively lubricates the sliding contact region of drum **27** and plate **34**. Plate **34** may extend the length of the sleeve **27**, or only part way as shown, longer plates being preferable.

An electrically conductive member, such as a plate **38** of metal, usually sheet aluminum, is disposed in the body of water, preferably merely resting on the bottom of the pan **28**. Pan **28** is made of electrically insulating material as shown. Alternatively the electrically conductive member may be a metal foil lining of pan **28**, or in some cases the pan **28** may be metal and electrically insulated from casing **15**. In any event the conductive plate or member is submerged in or in wide surface contact with the water in pan **28** and is electrically insulated from casing **15**.

Electrical energy is supplied as from a conventional 120 volt alternating current source plugged in at **39** and connected through a transformer **41**. The secondary of transformer **41** is connected through a rectifier **42** and a fixed resistor **43**, with the positive terminal lead **44** connected to plate **34** and the negative terminal lead **45** connected to plate **38**, so that about 1.5 to 12 volts direct current is applied between these plates as the motor **16** drives the humidifier rotor.

It has been found that, in operation of the foregoing described humidifier wherein the sleeve **27** is rotated at about one revolution per minute by motor **16**, by applying an electrolytic protection voltage of about 1.5 to 12 volts direct current with the positive anode terminal connected to plate **34** and the negative terminal connected to plate **38**, substantially no solid deposits accumulate in the pores of sleeve **27**. This condition continues over long periods of operation, appreciably longer than the hitherto accepted service periods requiring sleeve removal and cleaning, and it is expected that the humidifier should operate using the invention for at least an entire heating season without the need for inspection for pore deposits.

During the operation period, solids deposits may tend to accumulate in the pan **28** but these can be easily cleaned out fairly regularly by the home owner, without risk of damage to the rotor gearing.

Applicant's explanation of the advantageous phenomenon of operation of the foregoing is as follows. The solubilities of salts usually found in hard waters, such as calcium carbonate, increase with increased acidity of the water. Calcium carbonate is insoluble in neutral or alkaline water, but in acidic water it is converted to soluble calcium bicarbonate. The bicarbonate may even be converted to carbon dioxide if the hydrogen ion concentration is high enough.

When the electrolytic protection voltage is applied on lines **43**, **45** is ionized and hydrogen is liberated, and the water in the pores of sleeve **27** and at the positive plate electrode **34** becomes acidic, according to the following reaction:

$$2OH^- \rightarrow 2H^+ + O_2$$

Where the water being evaporated from the pores of sleeve **27** contains calcium carbonate, the following reaction takes place in the water in and adjacent the pores.

$$CaCO_3 + H^+ \rightarrow Ca^{++} + HCO_3^-$$

If the hydrogen ion concentration is sufficiently high the following reaction may take place, in which case there might be little if any solids deposit, even in pan **28**.

$$CaCO_3 + 2H \rightarrow Ca^{++} + H_2O + CO_2$$

As sleeve **27** rotates through the water of pan **28** the now soluble salts in solution on and in the sleeve pores are dissolved in the pan water wherein they may become concentrated and eventually require cleaning of the pan. In any event they are removed from the sleeve pores.

When the humidifier unit is initially started in operation, with relatively fresh clean water in the pan **28**, the foregoing operation is slow to start, but as concentration of dissolved salts increases in pan **28** efficiency increases and the invention becomes more effective with continued operation. It is sometimes advisable to dissolve a little soluble salt in the pan water upon installation or at the first of each season.

FIGURE 4 shows somewhat diagrammatically a further embodiment of the invention wherein a relatively stationary humidifier pad is protected against accumulation of solids.

An evaporator pad **51** which may comprise any suitable material such as porous plastic, plastic coated metal wool or mesh, or non-metallic fibers is mounted in a metal frame **52** that is attached by brackets **53** to a surrounding housing **54**. The lower end of the housing is formed to contain a reservoir body of water **55**, and the lower end of pad **51** extends beneath the water level. Water from nozzle **56** drips at a desired rate into the upper edge of pad **51** and spreads downwardly to be distributed over the entire pad area which is in the path of the air to be humidified. Excess water drains through pad **51** in the water body **55**. Water may be supplied to nozzle **56** either directly by conduit **58** connected to a source, or through conduit **59** from a pump **60** disposed in water body **55** which would be maintained at a constant level as by a conventional float controlled valve (not shown). The foregoing is essentially conventional structure.

The invention is applied to the FIGURE 4 structure by locating a conductive metal plate **61** immersed in the water body **55** and electrically insulated from the metal casing wall as at **62**, and securing a conductive metal plate **63** by electrically insulating brackets **64** upon frame **52** in full area contact with the adjacent face of pad **51**. Preferably plate **63** does not impede air flow through the pad to any appreciable extent.

A source **65** of direct current of between 1.5 to 12 volts has its positive side connected to plate **63** and its negative side connected to plate **61**, so that an electrolytic condition exists similar to that of the embodiment of FIGURES 1–3. The same action takes place in that the hard water insoluble salts are rendered water soluble and are dissolved in and carried off by the excess water leaving pad **51**.

The invention therefore provides a relatively simple, inexpensive arrangement which may readily be incorporated in existing humidifiers and which will substantially entirely eliminate problems caused by solids accumulating in the pores. Instead of accumulating in the pores, solids from the evaporated water are removed from the rotor or stationary pad and concentrated in the reservoir water which is easily replaced without disturbing any of the operating mechanism or damaging the drive gearing in the rotary type humidifier, or dismantling the stationary pad humidifier.

Beside polyurethane, other foamed plastics may be available such as foamed cellulose acetate, polyvinyl, chloride, polystyrene, polyethylene, phenolics, silicones and epoxy resins.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by Letters Patent is:

1. In a humidifier of the type characterized by a motor driven rotor having a peripheral surface of flexible porous electrically insulating material that rotates with its lower sector adapted to pass through a body of water and wherein the water picked up in the pores of said surface is raised for evaporation into an air stream or the like to be humidified, the improvement that comprises means for applying a small direct current voltage across terminals that are located respectively upon a conductive member in contact with said rotating surface remote from said body of water and a conductive member adapted to contact said body of water, the positive terminal being at said member contacting said surface.

2. In the humidifier defined in claim 1, a casing wherein said rotor is mounted, and said member contacting the pad comprising a metal plate mounted on the casing but electrically insulated from said casing.

3. In the humidifier defined in claim 2, said plate being a sheet of metal selected from the group consisting of stainless steel and aluminum polished on the surface contacting said pad.

4. In the humidifier defined in claim 1, a container of electrically insulating material for containing the body of water, and said member adapted to contact said body of water being a sheet of metal.

5. In the humidifier defined in claim 1, a container of electrically insulating material adapted to contain the body of water, said container being lined with metal foil serving as said second named member.

6. In the humidifier defined in claim 1, said members being sheet metal elements, the first of which is held in sliding contact with the rotor surface.

7. In the humidifier defined in claim 1, said rotor mounting an annular pad of open pore foamed polyurethane to provide said surface, and said first named member being a metal plate substantially tangentially bearing on said moving surface.

8. In a humidifier having a flexible porous evaporator pad having a lower portion adapted to be immersed in a body of water and including means for continually supplying water to said pad for evaporation into a stream of air traversing said pad, means for applying a relatively small direct current electrical potential to said pad comprising an electrically conductive metal element disposed in contact with a non-immersed region of the pad surface and an electrically conductive metal element adapted to be immersed in said body of water, and a source of potential having its positive terminal connected to the first named element.

9. In the humidifier defined in claim 8, said evaporator pad being a cylindrical sleeve of foam plastic adapted for rotation about its longitudinal axis, and said positive terminal comprising a smooth metal plate for bearing on the periphery of said sleeve.

10. In the humidifier defined in claim 8, said evaporator pad being a fixed pad.

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U.S. Cl. X.R.

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