

June 2, 1970

H. G. HILL
GRAVITY-IMPACT SYSTEM FOR WATER
DISTRIBUTION IN HUMIDIFIERS

3,515,378

Filed Feb. 26, 1968

3 Sheets-Sheet 1

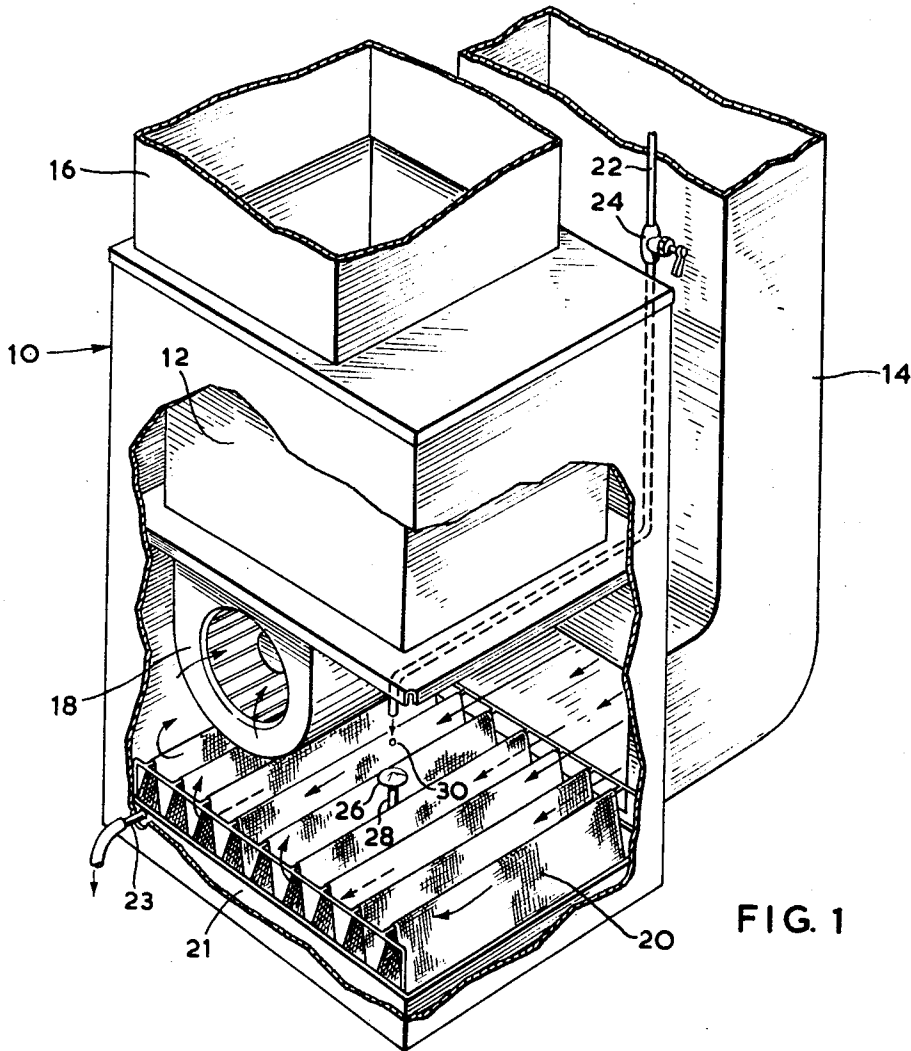


FIG. 1

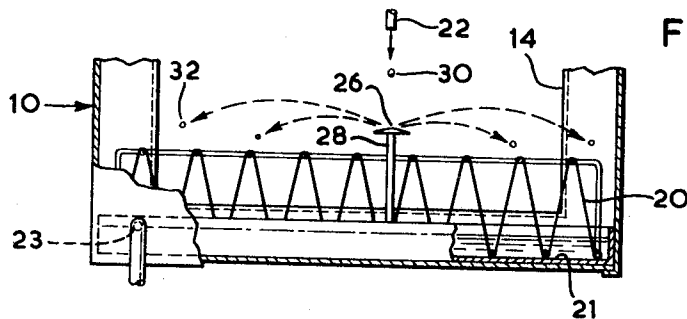


FIG. 2

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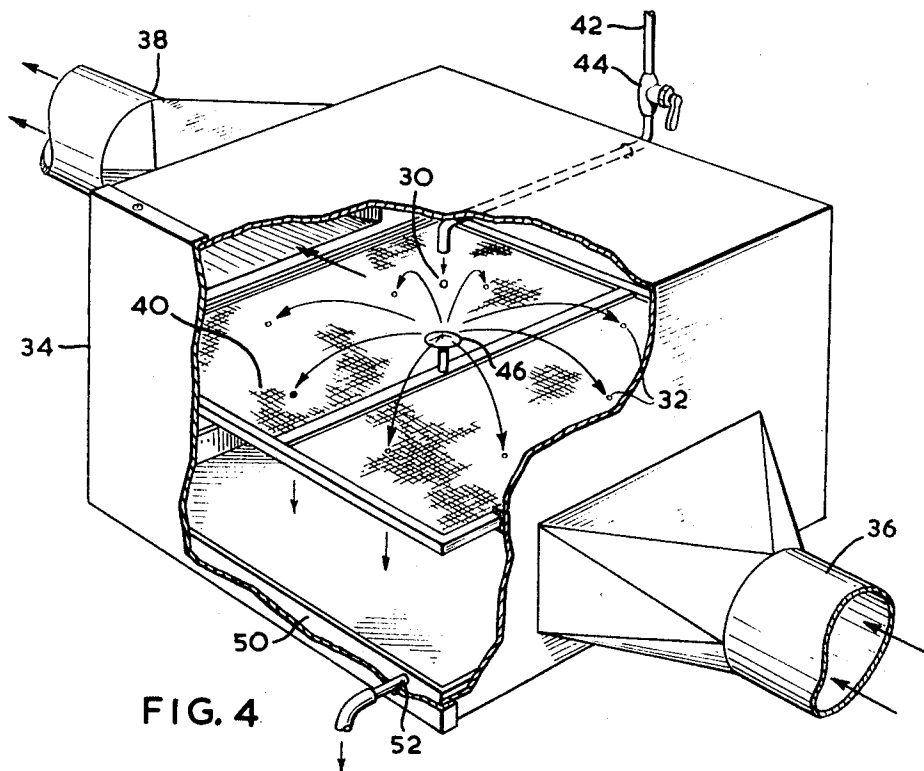
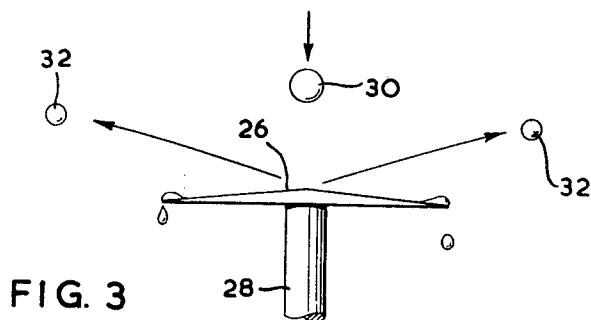
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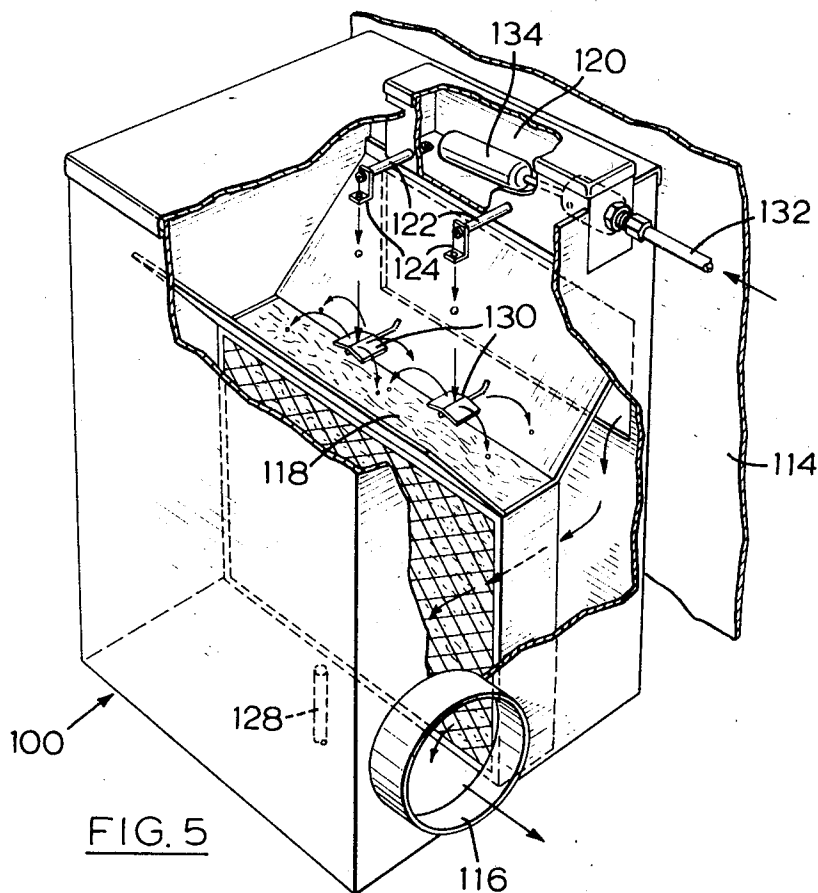


FIG. 5

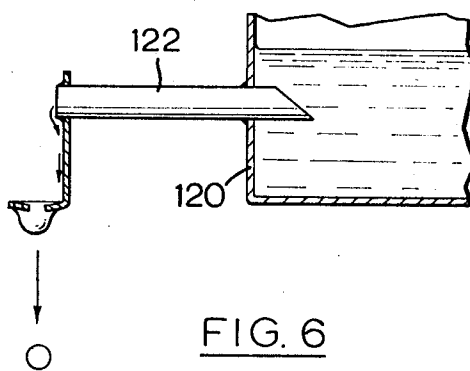


FIG. 6

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**GRAVITY-IMPACT SYSTEM FOR WATER
DISTRIBUTION IN HUMIDIFIERS**Harold Gordon Hill, 530 Lacroix St.,
Chatham, Ontario, CanadaContinuation-in-part of application Ser. No. 443,413,
Mar. 29, 1965. This application Feb. 26, 1968, Ser.
No. 708,116

Int. Cl. F24f 3/14

U.S. Cl. 261—106

5 Claims

ABSTRACT OF THE DISCLOSURE

The application discloses a humidifier for attachment to a warm air furnace in which water from a supply is formed into drops which strike an underlying target device and are thereby dispersed over a water absorbing pad. The pad is located in the air path of air that is to be conditioned with moisture and it is adapted to give up moisture to the air which passes through it. An orificed plate is used to form the water into large drops prior to being directed on to the drop dispersing target. The pad then is moistened by the dispersed water drops and it in turn gives up its moisture to air that is directed there-through.

This application is a continuation-in-part of pending application Ser. No. 443,413 filed on the 29th day of March, 1965, and now abandoned.

This invention relates to a humidifier for use with gas-fired or oil-fired forced air furnaces, electric heaters and unit humidifiers intended as accessories for these furnaces and heaters.

It is well known to those skilled in the humidifier art to construct humidifiers in which distribution of water is obtained by pressure atomization, centrifugal action, slinger devices, absorption in porous materials and by steam jets. Other humidifiers are equipped with multi-port weirs which distribute water over an evaporating pad or extended surface. In some cases, re-circulating pumps are required to produce effective results.

Calcium carbonate in solution with other chemicals and dissolved solids in water has created a difficult lime problem with such humidifying equipment for many years. As the water evaporates in the humidifier and the plates become dry, the lime and solids soon clog pores in evaporating pads or plates so that they become less effective. Plugged float valves often cause water to overflow from a pan humidifier mounted in a furnace plenum and the heat exchanger may rust through before the owner is aware of the problem. In addition, the equipment is relatively costly to build and maintain. This invention avoids these problems.

An object of this invention is to provide a humidifier with a minimum of complex working parts and that requires a minimum of service.

A further object of this invention is to provide a simple and economical humidifier wherein the evaporating pad can be kept constantly wet with a small water supply rate which does not have a tendency to clog with lime deposits in use whereby little servicing is required.

A further object of the invention is to provide a humidifier that can be designed for top or bottom mounting with respect to the heater with which it is used.

A further object of the invention is to provide a humidifier that is not likely to overflow in use.

With these and other objects in view, a humidifier according to this invention comprises a housing formed with a through passage for the flow of air, a water absorbing pad in the through passage of said housing, from

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which moisture can be evaporated into air passing through said air passage in use, means for controlling a supply of water and depositing the water in drop form, drop dispersing means underlying said means for depositing a supply of water in drop form, said drop dispersing means having a downwardly sloping surface adapted to break up drops of water dropped onto it and disperse them laterally thereof in a dispersion pattern, said water absorbing pad underlying said drop dispersing means in the dispersion pattern of said drop dispersing means, said means for depositing a supply of water in drop form being above said drop dispersing means a distance sufficient to impart sufficient kinetic energy to drops of water supplied thereby to cause them to break up and disperse laterally in a dispersion pattern, collecting means underlying said water absorbing pad for collecting excess water and drainage means from said collecting means.

The invention will be understood after reference to the following detailed specification read in conjunction with the drawings.

In the drawings:

FIG. 1 is a perspective view broken away to illustrate construction of a furnace incorporating a humidifier according to this invention;

FIG. 2 is a fragmentary sectional view of the evaporating surface of the humidifier of FIG. 1;

FIG. 3 is an enlarged sectional view of the target showing the downwardly sloping target surface thereof;

FIG. 4 is a perspective view of a unit humidifier intended for installation between the warm air plenum and return air duct of a forced air furnace or heater;

FIG. 5 is an illustration of an alternative embodiment of the invention; and

FIG. 6 is a detail of a water supply outlet and drop forming plate on the embodiment of the invention of FIG. 5.

Referring to the drawings, FIG. 1 illustrates a conventional gas-fired air heater furnace 10 which may alternatively be fired by oil or electric resistance heating elements according to standard practice. The heater has a housing, generally indicated by the numeral 12, and which is in communication with a return air duct 14 and a heated air outlet duct 16. In use, cold air passes from the cold air duct 14, through the heater unit and out the outlet hot air duct 16 under the influence of the air circulating fan 18. The unit is connected to the heating system in a building according to standard practice.

Reference to the standard type heating unit 12, through which the air passes in heat exchange relation, is minimal in this application because the invention concerns the humidifier unit that is mounted within the housing 10. The housing of the furnace in this case also serves as a housing for the humidifier structure.

The humidifier structure in this case is mounted at the bottom of the housing 10, within which is defined a passage for air flow from the return air duct 14 to the inlet of the circulating fan 18, as indicated by the arrows.

A water evaporating surface, preferably comprised of a porous pad 20 made from a woven cotton fabric stretched over a metal supporting frame and formed into a series of peaks and valleys, is in moisture transfer relation with air travelling the said passage so that moisture can be transferred from the surface of pad 20 to air passing thereover as it travels from the air return duct 14 to the input of the air circulating fan 18. The pad 20 is mounted in a pan 21 which has a drain outlet 23 spaced from its bottom whereby water, in excess of that evaporated in use, can accumulate in the pan below the drain outlet 23.

Water is supplied to the water evaporating surface of pad 20 and the pan 21 from the water supply pipe 22,

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which has a valve 24 therein for controlling the flow, as will be described later. Distribution means for distributing water from supply pipe 22 over the evaporating surface of the pad 20 are provided in the form of a target 26 rigidly supported by means of a support 28 above the evaporating surface of the pad 20 and the overlying outlet of the pipe 22, which is adapted to drop water in drop form on the target.

The target 26 has a target surface underlying the outlet of the pipe 22 that slopes in a downward direction and is adapted to break a substantial portion of each drop of water that drops onto it into a plurality of smaller dispersed drops, to impart to the dispersed drops a portion of the kinetic energy of the drop from the water outlet and to prevent water accumulation at the target surface of the target whereby part of the water dropped from the outlet of pipe 22 is dispersed in a direction having a horizontal component and over the evaporating surface of the pad 20.

It will be noted that the surface of the target 26 is convex and slopes in a downward direction so that when a drop of water from the water supply line 22 strikes it, as indicated in, say, FIG. 3 of the drawings, there is sufficient slope or fall away at the target surface in a downward direction to facilitate the ready breaking up of the drop into smaller drops and their dispersion in a horizontal direction.

It will be apparent that, if the target surface of the target 26 were flat, that a pool of water would tend to accumulate where the drops hit the target area that would absorb the kinetic energy of the falling drops and prevent their horizontal dispersion. If, on the other hand, the slope of the target surface in a downward direction were too great, the falling drops would tend to slide down the sloping target surface without breaking up and dispersing.

The amount of slope in a downward direction is one that is adapted, as indicated above, to break a substantial portion of each drop of water from the water supply line 22 into a plurality of smaller dispersed drops and to disperse them horizontally. The sloping surface additionally serves to draw off water from the drops that is not dispersed horizontally whereby to avoid the formation of a pool on the target area of the target that would absorb the kinetic energy.

The outlet of the water supply line 22 must, of course, be sufficiently spaced above the target area to allow drops of water dropped therefrom to gain sufficient kinetic energy to achieve good dispersion over the evaporating surface of the pad 20.

The amount of slope to achieve a desired result can be readily determined in any instance. The principles upon which the determination is made have been noted above, that is, the slope must be great enough to avoid the formation of a pool of water that would absorb the kinetic energy of the falling drops and to facilitate horizontal dispersion. On the other hand, it must not be so great that the falling drops slide off without dispersing a substantial portion thereof. By way of practical example but without any intention of limiting the scope of this invention, a convex target 26 having a two-inch diameter and a target area with a slope in a downward direction of about five degrees located about seven inches from water supply pipe 22 in a humidifier provides a satisfactory dispersion of falling drops in a horizontal direction over the pad 20.

In use, the humidifier structure at the bottom of the casing 10 imparts moisture to air as it travels over the evaporating surface of pad 20 in its path from the return air duct 14 to the circulating fan 18. Water supply 22 is connected to a pressurized supply of water and the valve 24 is opened to permit water to drip in dropform from the outlet of the water supply pipe 22 and impinge upon the downwardly sloping target surface of the target 26. The target surface of target 26 is, as noted above, sloped to disperse a substantial portion of each drop 30 that impinges upon

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it into a plurality of drops 32 and to spread them over a substantial area of the underlying pad 20. The portion of the drops 30 that are not dispersed laterally roll away from the target surface portion of the target 26 and off of the edge of the target. It will be noted that there is a slight accumulation of water at the edge of the target 26 due to surface tension. This accumulation, however, is spaced from the target surface where the drops 30 strike the target 26.

The flow rate from the line 22 is sufficient to cause an accumulation of water in the pan 21 which overflows through the drain outlet 23. In a unit where up to eight gallons of water a day are imparted to air passing over the pad 20, a water flow rate that provides for a drain-off through the drain outlet 23 of about half a gallon an hour will ensure that there is not an undue build up of solids from the water that is evaporated on the pad 20. The constant flow of water through the unit in excess of the requirements for evaporation prevents a rapid build-up of lime and other solids and over a normal heating season. Build-up can be prevented to an extent that it is not necessary to remove the evaporating pad 20 for cleaning. A certain amount of build-up is, of course, unavoidable. The pad 20 illustrated in FIG. 1 has an area of eighteen inches by eighteen inches in plane and the crests are four inches high. Over an entire heating season, such a pad was reduced in efficiency of evaporation from eight to five United States gallons a day on the basis of air with a return humidity of about twenty-five percent, due to the build-up of solids. This is not an intolerably large reduction in evaporating efficiency due to solids from evaporation and it is the result of a full season's operation.

In the embodiment of the invention illustrated in FIG. 1, the air passes over and under the pad 20 in the direction of the hills and valley and absorbs water from the surfaces which are moistened, as indicated above, by the dispersed drops 32. The circulating fan 18, of course, forces air through the heater 12 and out the heated air outlet duct 16 to the rooms to be heated.

In FIG. 4 of the drawings, there is illustrated a further embodiment of the invention. This humidifier unit has its own casing 34, and it is attached to a warm air furnace between the warm air plenum and return air duct. It has an inlet 36, which is in use connected to the warm air plenum, and an outlet 38, which is in use connected to the return air duct. A pad 40, made from a coarse weave material, such as nylon, an aluminum mesh or a fibrous fabric, which can be wetted but which will not overly resist the flow of heated air therethrough as it passes from inlet 36 through the pad and out outlet 38, is provided. Means for dispersing water over the pad are provided, as in the embodiment of the invention illustrated in FIGS. 1 and 2. These means include a supply pipe for water 42, having a valve 44 that is adapted to permit water to drop from the outlet of pipes 42 onto a target 46 which is similar in design to the target 26. It has the target 46 adapted to disperse drops of water over the pad 40 to make it moist so that moisture can be transferred from the pad to the dry air circulating through the casing 34 as it travels from inlet 36 to outlet 38. At the bottom of the casing 40 there is a pan 50 adapted to collect the excess moisture that is not absorbed by the pad 40, and pan 50 has an overflow pipe 52 which is adapted to function as overflow drain outlet 23 to take off excess water from the humidifier unit.

In use, as before, water is caused to flow from the pipe 42 at the sufficient volume to wet the water absorbing pad 40 and to maintain a continuous flow of water through the drainage outlet 52 at a volume sufficient to prevent undue build-up of solids from the evaporation process. The inlet opening 36 is connected to the warm air plenum of a hot air furnace and feeds back a portion of the hot air going to the rooms through the humidifier unit to the cold air inlet to the furnace. The air is fed

back through the humidifier unit, takes on moisture as it passes through the pad 40 and is humidified.

A further embodiment of the invention is illustrated in FIGS. 5 and 6 of the drawings. In this case, the humidifier unit is generally indicated by the numeral 100, and it is connected in by-pass fashion from the warm air supply duct of a hot air furnace to the return cold air duct of a furnace. In this connection, duct 114 connects with the warm air supply duct outlet of a furnace and duct 116 connects with the return cold air duct of the same furnace so that, in use, pressure difference between the warm air supply duct and the return cold air duct causes a flow of warm air from the warm air supply duct of the furnace through the humidifier unit 100 and to the return cold air duct. Thus, a portion of the air going to the rooms through the warm air supply duct is by-passed back to the return cold air duct, and as it is so by-passed, it picks up moisture from the moistened pad in the humidifier unit 100. The general method of connecting a humidifier in this by-pass fashion is not basically new, and no claim is being made to it in this application. This invention is concerned essentially with the moistened pad of the humidifier which is maintained in a moist condition by means of drops of water that are dispersed by drop dispersing means.

In this case, the heated air is passed through a pad 118, which is mounted directly in the air flow and which is maintained in a moistened condition by water that flows from the reservoir 120 through the outlet tubes 122 down onto the drop forming plates 124.

Drop forming plates 124 underlie water outlets 122 and are adapted to receive water supplied from the reservoir in use. The drop forming plates 124 are each formed with an orifice through which the water that is deposited thereon can pass. It will be noted that the surface of each plate is slightly dished so that water flowing thereon is guided towards the orifice.

The underside of each of the plates is substantially horizontal so that, as water flows through the plate surface, surface tension at the marginal areas of the orifice on the underside of the plate tends to hold the water on the underside of the plate and permit it to form into large drops before it drops therefrom down onto the targets 130.

The surface tension on the water tends to cause the water first to wet the substantially horizontal marginal portions of the hole on the underside of the plate and then form it in large drops which are directed to the drop dispersing targets 130 that underlie the openings of the drop forming plates and that have downwardly sloping surfaces adapted to break up the drops of water dropped onto them and disperse them laterally in a dispersion pattern over the underlying evaporating pad 118.

The evaporating pad 118 is of known manufacture and is absorbent in nature and the water sinks therethrough so that it is in effect essentially moist from top to bottom at all times. The amount of water flowing from the water outlet 122 and which is dispersed over the top of the pad and sinks therethrough is sufficient such that the pad is always maintained moist. There is always an excess of water which is drained off to a drain 128 at the bottom of the pad 118.

The purpose of the drop forming plates is to form the water in large drops and they achieve this purpose by reason of their substantially horizontal under surfaces onto which the water can run. The plates could assume a different form to that shown. It is only necessary that the water flow onto a substantially flat under surface whereby the surface tension of the water will cause the water to form into large drop form before dropping onto the dispersing targets 130. The orificed form of the plates shown is preferred because, by aligning the orifice directly above the targets 130, one can control the dropping of the water adjacent the peak of the target.

The reservoir 120 from which the water supply proceeds is supplied from a water main through the supply conduit 132. The level of the water in the reservoir 120 is maintained by means of float valve 134. In practice, float valve 134 operates to maintain the water level in the reservoir a predetermined amount above the level of the input to the conduit 122. In this way, the head of water at the supply conduit 122 is maintained constant and the flow rate is therefore constant. Head is therefore automatically maintained by means of the float valve 134.

It will be appreciated that the reservoir, automatically controlled as to level in this way, provides a very small hydraulic pressure for the water supply to the evaporating unit, and relatively large diameters can be used for the tubes 122. Water head above the tubes 122 is preferably in the order of one-half of an inch. A water metering orifice of about $\frac{3}{32}$ of an inch in diameter for the tube 122 is quite practical. The larger diameter supply pipe can be maintained clean easily in a device of this nature.

By using the drop forming plates 124, one can increase very substantially the water capacity of a unit as compared with the smaller drops formed by higher pressure flow through a small diameter tube without the drop forming plates. Without the drop forming plates, one tends to get a stream rather than drops if one tries to increase the flow rate too much by means of valve control only. It is possible that one may have the supply water turn into stream form at a flow rate as low as 50 ounces per hour when using a tube of small diameter and a valve control. The supply to the dispersing heads 130 must, of course, be in drop form, otherwise adequate dispersion is not achieved.

By using the drop forming plates 124, one can quite easily achieve a drop output at a rate of about 125 ounces per hour.

It will be noted that, in the embodiment of FIG. 5, two water outlets 122 from the reservoir 120 have been provided for extra capacity. It will be apparent that in such a case the two outlets must be adjusted so that they are on the same level, otherwise irregular water supply would result.

The diameter of the orifice in the drop forming plates 122, in the case of the humidifier illustrated, is about $\frac{1}{8}$ of an inch.

However, in modern homes of up to eight rooms, one water outlet from the reservoir is capable of supplying sufficient water to maintain the humidifier evaporating pad 118 moist at all times.

What I claim as my invention is:

1. A gravity-impact system for water distribution to evaporative pad means in a humidifier having a housing formed with a through passage for flowing air over said pad means located in said passage and the humidifier having means underlying said pad means for collecting and draining excess water, said distribution system comprising:

- (a) water supply means including means for controlling its flow and including outlet means for dripping the water in the form of a succession of individual drops;
- (b) drop dispersing means located beneath the dripping means and above said pad means, the lateral extent of the drop dispersing means being small as compared with the lateral extent of the surface of the pad means whereby said pad means are exposed therebelow and including a substantially transverse drop-impinging target surface sloping from a central point downwardly and outwardly at a small angle to the horizontal, the impinging target surface being located directly below said dripping means a distance which is great as compared with the lateral extent of the drop dispersing means to impart kinetic energy to said drops of water, said angle and said distance being sufficient to break up a substantial

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portion of each drop of water into a plurality of smaller drops and to disperse said smaller drops laterally thereby to fall upon said pad means located within the pattern of their dispersion and to drain off water from said dispersing means that is not broken into smaller drops.

2. A humidifier as claimed in claim 1, in which said water supply means includes a reservoir, said reservoir having automatic means for maintaining a predetermined level of water therein, a conduit extending outwardly from the reservoir and communicating with the water therein a predetermined distance below said maintained level, and the outer end of the conduit comprising said outlet means.

3. A humidifier as claimed in claim 1, in which said water supply means includes a water supply line having an outlet, means for metering the flow of water there-through, a drop forming plate underlying said outlet and disposed to have water therefrom flow onto the plate, said drop forming plate having an orifice therein and a substantially horizontal undersurface disposed to receive and temporarily hold water flowing onto the plate and through said orifice against said undersurface to form successive drops which fall of their own weight from the undersurface.

4. A humidifier as claimed in claim 3, in which said water supply means includes a reservoir, said reservoir having automatic means for maintaining a predetermined

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level of water therein, a conduit extending outwardly from the reservoir and communicating with the water therein a predetermined distance below said maintained level, and outer end of the conduit comprising said outlet.

5. A humidifier as claimed in claim 3, said drop forming plate being dished at its upper surface to slope toward said orifice to guide water flowed onto the plate through said orifice.

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U.S. Cl. X.R.

261—115