Aug. 11, 1970 R. C. JAYE 3,523,681

EVAPORATOR UNIT

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Fig. 1.

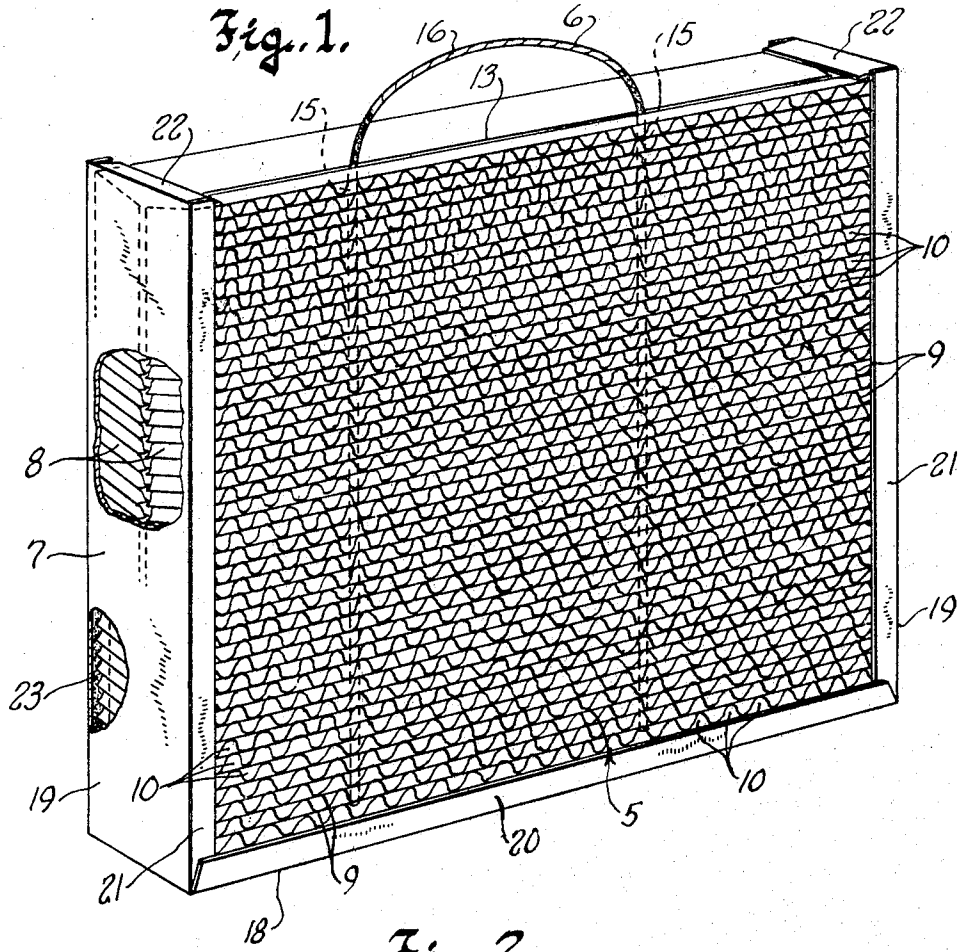
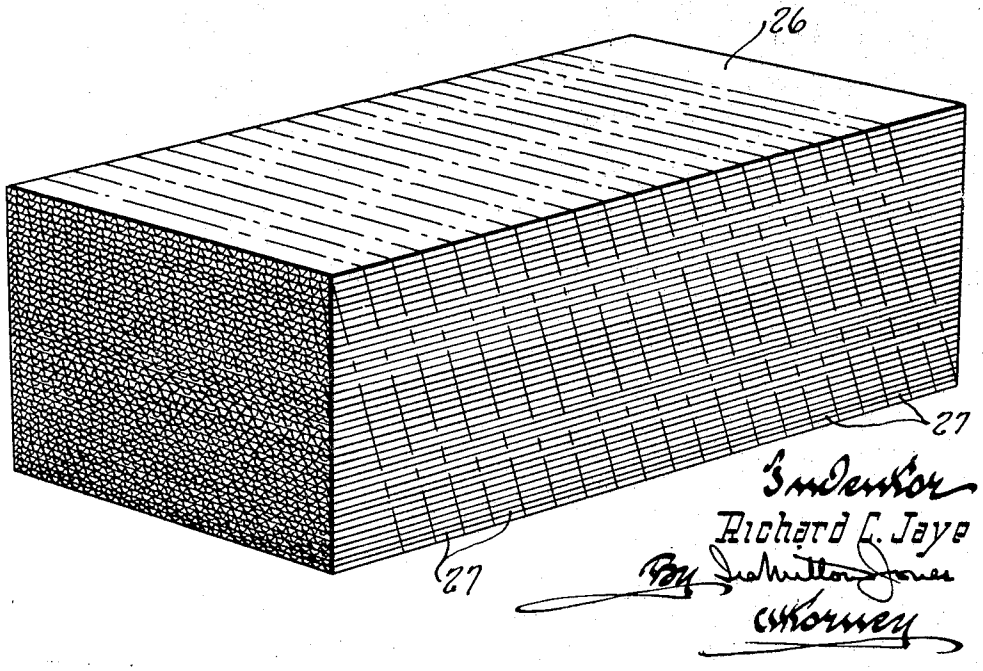


Fig. 2.



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EVAPORATOR UNIT

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Fig. 3.

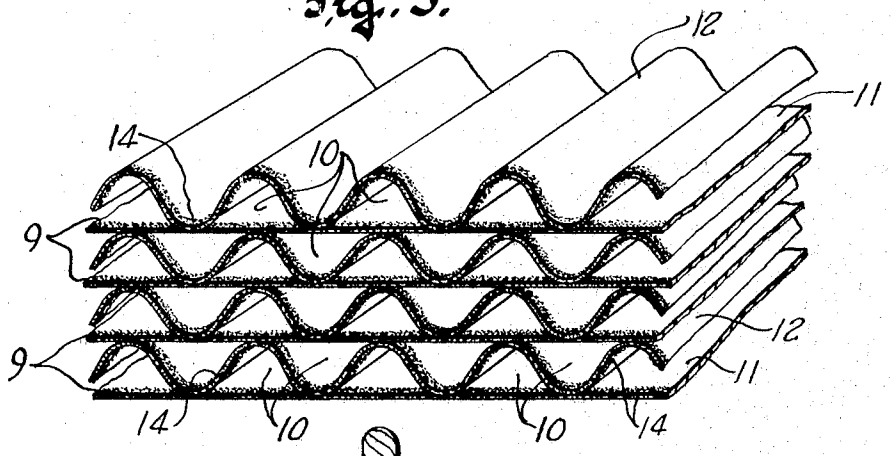
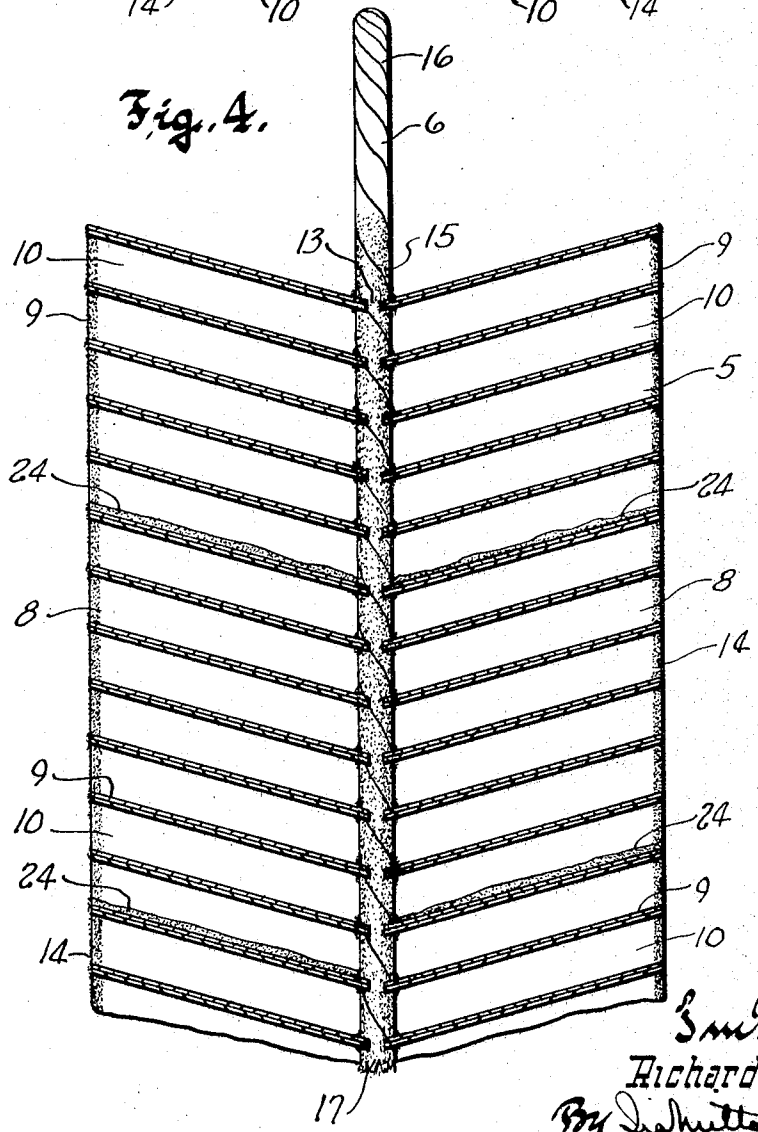


Fig. 4.



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Fig. 5.

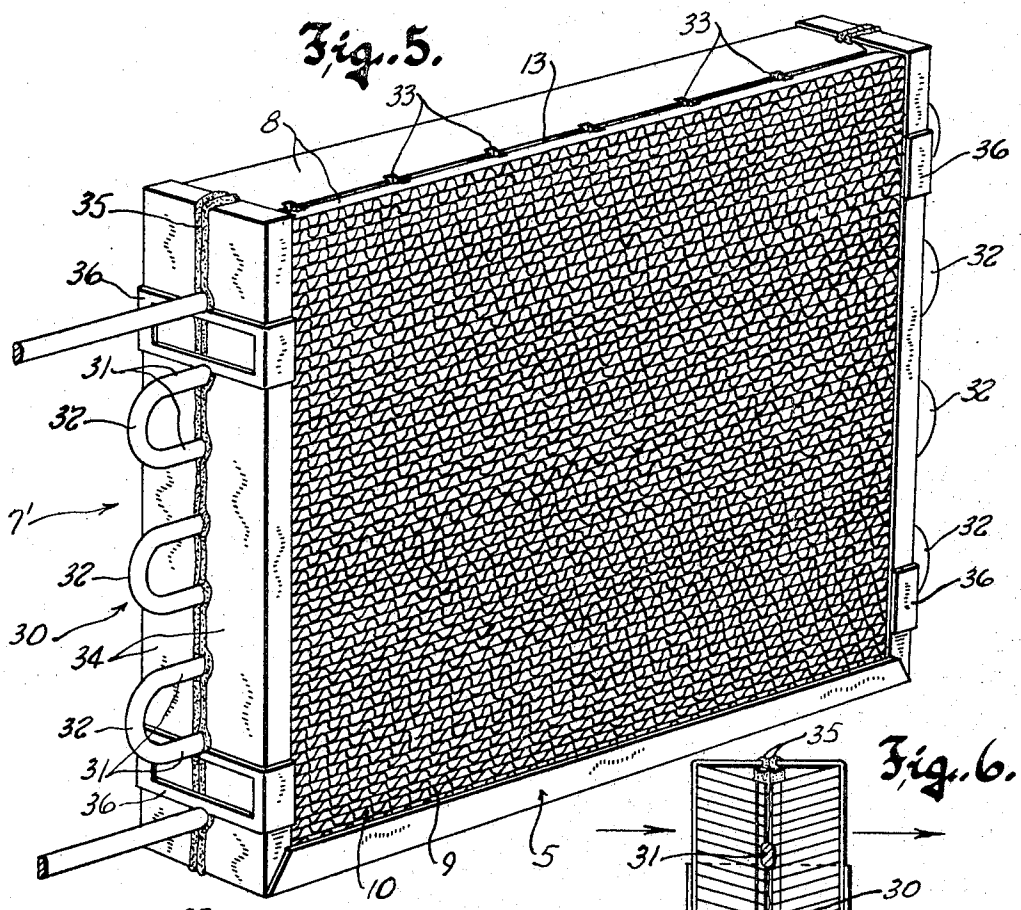


Fig. 6.

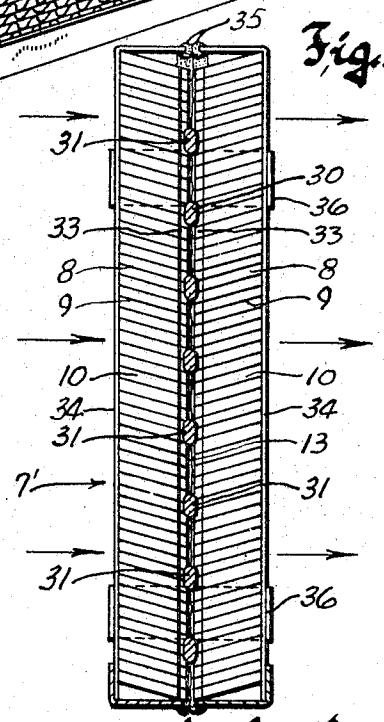
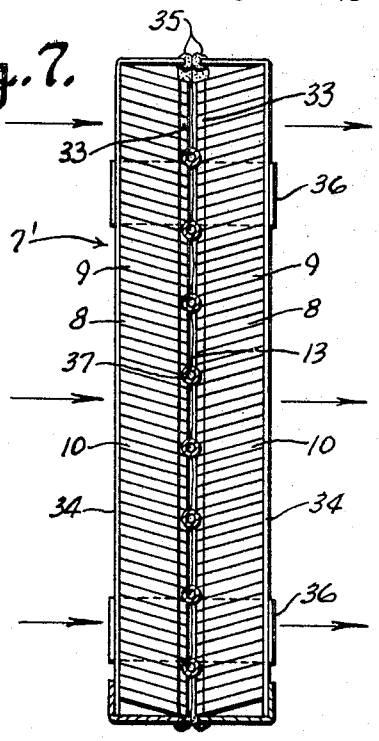


Fig. 7.



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United States Patent Office 3,523,681 Patented Aug. 11, 1970

3,523,681

EVAPORATOR UNIT

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Continuation-in-part of application Ser. No. 742,355, July 3, 1968. This application Sept. 12, 1968, Ser. No. 767,033

Int. Cl. B01d 1/02

U.S. Cl. 261—142 7 Claims

ABSTRACT OF THE DISCLOSURE

An evaporator unit having a honeycomb body comprised of a pair of flatwise adjacent but spaced apart body sections each consisting of superimposed strips of absorptive corrugated paper-like material. On the outer faces of the body to which the honeycomb cells open, a cured synthetic resin coating renders the body substantially rigid without interfering with air flow through the cells to pick up moisture from water introduced into the body through the space between the body sections. Optionally, heating means in the body can promote evaporation of water therefrom; and condensation of a gaseous medium circulated through a duct embedded in the body can also be efficiently accomplished due to the cooling effect produced by evaporation of water from the body while air is forced therethrough.

This application is a continuation-in-part of my application Ser. No. 742,355, filed July 3, 1968, and also relates to evaporator units of the type comprising a water absorptive cellular body which, when wet, will give up moisture to air circulated through the body cells. More particularly, this invention concerns improvements in evaporator units such as disclosed in the U.S. patent to J. F. Hirtz, No. 3,278,175, issued Oct. 11, 1966.

That patent discloses a humidifier characterized by an evaporator pad comprising a substantially tightly rolled spiral of corrugated asbestos paper mounted in a frame, and providing a honeycomb body with a multiplicity of cells. The walls of the cells, being of asbestos paper, have good water absorptive properties and collectively provide a large surface from which water introduced into the body can be evaporated, so that moisture will be readily picked up by air circulated through the cells from one face of the body to the other.

While the evaporator pad of the Hirtz patent was satisfactory in many respects, it had certain disadvantages which this invention overcomes. Chief among its objections was the necessity for mounting it in a frame having grill work to engage the opposite faces of the pad and help support it against collapse when wet. This obviously entailed an expense which would not have been necessary if the evaporator body were self supporting when wet.

In addition, air flow through the honeycomb cells was apt to be impaired by the spiral winding of the strips comprising the body, especially if the spiral were wound too tightly.

The primary objects and purposes of this invention are realized in an evaporator unit having a honeycomb body comprised of water absorptive material such as a corrugated paper-like strip material with the corrugations defining cells that open to the opposite faces of the body, wherein water can be introduced into the interior of the body for absorption by the walls of its cell and for evaporation and transfer to air circulated through the cells, and wherein a coating of a substantially unyielding water impervious material on the opposite faces of the body renders the same substantially rigid and self supporting when wet as well as when dry.

It is also a purpose of the invention to provide such an evaporator unit with heating means, in its interior, to promote vaporization of water from its surfaces; and to provide for condensation of a gaseous medium circulated through a duct embedded in the body of the unit.

The manner in which the invention achieves its purposes will be appreciated from the following description and the accompanying drawings. This disclosure is intended merely to exemplify the invention. The invention is not limited to the particular structure disclosed, and changes can be made therein which lie within the scope of the appended claims without departing from the invention.

The drawings illustrate several complete examples of the physical embodiment of the invention constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

FIG. 1 is a perspective view of an evaporator unit embodying this invention, a portion thereof being broken away to illustrate interior construction;

FIG. 2 is a perspective view showing how slabs can be cut from a loaf of honeycomb material to provide cellular bodies for evaporator units of this invention;

FIG. 3 is a fragmentary perspective view, at an enlarged scale, of a face portion of an evaporator unit of this invention;

FIG. 4 is a fragmentary cross sectional view through a modified form of evaporator unit, at an enlarged scale;

FIG. 5 is a perspective view of an evaporator unit in which heating means promotes vaporization and enhances the efficiency of the unit;

FIG. 6 is a cross sectional view through the unit seen in FIG. 5; and

FIG. 7 is a cross sectional view of still another form of the invention, suitable for use as a humidifier or as a condenser unit.

Referring now to the accompanying drawings, the evaporator unit of this invention comprises an upright body 5 of honeycomb construction, a handle 6 accessible at the top of the body, and optionally, a frame 7 around bottom and opposite side portions of the body.

The body 5 is comprised of a pair of flatwise adjacent body sections 8, which can be identical. Each body section 8 comprises a stack of elongated flatwise superimposed strips 9 of corrugated paper-like material wherein the crests and valleys of the corrugations extend transversely across the strips and cooperate to provide closely adjacent honeycomb cells 10 that open to the opposite faces of the body section.

The strips are preferably made of asbestos paper because of its porous or water permeable nature, and each such strip can be of single-faced corrugated stock consisting of a first sheet 11 sinuously formed with alternate crests and valleys to provide the corrugations, and a flat second sheet 12 permanently bonded to the crests of the first sheet at one side thereof.

According to this invention, the body sections are rendered substantially rigid and form retaining, even when saturated with water, by means of a coating 14 of substantially unyielding water impervious material, such as a cured synthetic resin, on only the end edges of the cells at those faces of the body which are remote from one another and outermost on the assembled unit (see FIGS. 3 and 4). The uncoated faces of the two body sections are disposed in flatwise opposing relation, with a slight space 13 between them. They are held in such spaced apart relation by a pair of spacer members 15, which can be the opposite stretches of a U-shaped cord having its closed end 16 uppermost to provide the handle 6. The cord can also be made of asbestos material, or fiber glass if desired, and it can also have a coating of cured synthetic resin on its stretches, as indicated at 17, to stiffen

it and to bond it to the adjacent faces of the body sections. The cord can be of size substantially equivalent to a number nine wire.

The resin coating 14 on the outer face of each body section serves to rigidly bond together and unify the whole stack of trips 9 of which the body section is comprised. Due to the honeycomb construction, the coating 14 can be said to produce a non-yielding grillwork of great strength for the exposed face of the body section. The coatings 14 on the body sections also cooperate with the spacer members 15 that are bonded to the inner faces of the body sections to produce an unusually strong evaporative body, despite the fact that the body is made of corrugated asbestos sheet material which, though having good water absorbing properties, has very poor form retaining qualities when wet.

Moreover, this desirable result is achieved without in anywise interfering with water penetration into the walls of the body cells inwardly of the coatings 14. Because the resin coatings render only a negligible percentage of the cell walls non-absorbent, at the end extremities of the cells, substantially the full absorptive capacity of the evaporator unit is assured.

The body sections 8, with the spacer cord between them, can be mounted in the frame 7 as shown in FIG. 1 with its handle 6 uppermost. The frame can be advantageously fabricated from substantially light gauge sheet metal, and it comprises a bottom member 18 and opposite upright side members 19. The bottom member 18 extends along the underside of the body 5 and has opposite upstanding side flanges 20 which embrace lower marginal portions of the body. The side members 19 extend upwardly along the side edges of the body that are defined by the ends of the strips 9, and opposite flanges 21 on the side members similarly embrace side edge portions of the body. Tabs 22 bent donwardly over the top of the body from the upper ends of the side frame members 19 cooperate with the flanged frame members to securely hold the body 5 of the unit in place. If desired, a synthetic resin can be applied to the inner surfaces of the flanges 20 and 21, as at 23, so as to permanently bond the same to the outer faces of the body when such resin is cured as by baking.

One of the features of the evaporator unit described, is that the stretches 15 of the cord confined between the body sections define a space therebetween that constitutes duct means by which water can be introduced into the body of the unit. Water is introduced into the body for the purpose of moistening and permeating the walls of the honeycomb cells so that moisture will be transferred to air circulated through the honeycomb body, through evaporation.

It should be noted that the strips of corrugated paper of which the body sections are formed extend at a slight downward and inward inclination toward the space between the sections as seen best in FIG. 4. This gives the advantage of far better contact between air circulated through the body and the moistened walls of the honeycomb cells and avoids straight-through flow that tends to result in inefficient humidification.

Because of the slant of the strips, the topmost strips of the body sections cooperate to define a trough into which water can be introduced, and which trough will direct the water toward and into the space 13 between the body sections. Water thus fed into the evaporator body runs down onto the inner edges of the strips of corrugated material on each body section, to be drawn outwardly along the walls of the honeycomb cells by capillary action and thus thoroughly moisten the surfaces and permeate the walls of the cells.

Because of the size of the honeycomb cells and the space 13 between them, air can be easily circulated serially through the cells in first one body section and then the other, despite any axial, misalignment between the cells of the two body sections. As the air passes through the cells, of course, moisture will be evaporated from the moistened walls of the cells and transferred to the air to humidify the same.

One of the features of the evaporator of this invention resides in the fact that, though the absestos paper of which the body is comprised tends to become quite supple when wet, the body is nevertheless capable of retaining its form even when soggy wet with water, and does not require grillwork in firm contact with its opposite faces to help support it. The evaporator body is able to support itself by reason of the cured synthetic resin coating 14 on the outer edges of the strips of which the body sections 8 are comprised. In fact, it is not even essential that the body be mounted in a frame such as described and such a frameless unit is disclosed in FIG. 4.

The evaporator unit seen in FIG. 4 similarly comprises a pair of body sections 8 which are held against displacement out of the relationship described earlier by having their outer as well as their inner faces permanently joined to the spacer members 15 between them. The inner longitudinal edges of the corrugated strips in both body sections are directly adhered to the spacer members 15 as described before, while the rigid outer edges of the strips having the cured synthetic resin coating 14 thereon are indirectly joined to the spacer members. This is effected by flowing synthetic resin inwardly and downwardly along selected honeycomb cells, as indicated at 24 in FIG. 4, to create bridges of such adhesive between the coated and rigid outer faces of the body sections and the similarly coated and more or less rigid spacer members 15 between the body sections. The outer faces of the body can be joined to the spacer members 15 by as many such bridges along their length as needed to achieve the desired rigidity of the frameless evaporator unit, after curing of the resin.

FIG. 2 indicates how it is possible to inexpensively produce body sections 8 such as described, wherein the cells of each section are inclined out of normal with respect to the opposite faces of the section by a small acute angle. As therein seen, a number of strips of corrugated paper-like material, of uniform width, are flatwise stacked to form a loaf 26 wherein the corrugations of all of the strips extend lengthwise of the loaf. Slices or slabs each of a thickness corresponding to that of the body sections 8 are then cut off the loaf, along lines 27 having the same angular divergence from vertical as that of the cells from horizontal, in FIG. 4. These slabs or slices provide the body sections 8, and cutting thereof from the loaf can be readily performed on a metal band sawing machine, which is preferred if the corrugated paper like material of the loaf is of asbestos.

Cutting of the slabs from the loaf is best performed when the strips comprising the loaf are more or less temporarily glued together. An adhesive such as sodium silicate applied to the strips being stacked can be used to advantage for that purpose.

The evaporator unit shown in FIG. 5 features a heating coil 30 snugly confined between the complementary body sections 8 of which the evaporator unit is comprised. The purpose of the heating coil is to promote vaporization of water from the absorptive surfaces of the honeycomb body, and thus to render the unit more efficient for humidification. Since the heating coil 30 also serves to hold the body sections 8 spaced apart, the cord previously used for that purpose can be eliminated.

The heating coil can be an electrical heating element of a type known as a "Calrod" unit, and it can have a number of horizontal stretches 31 that are here shown as extending parallel to the strips of which the body sections are comprised. At each side of the body and at its exterior, adjacent stretches of the heating element are joined by integral bends 32.

When the stretches of the heating element extend horizontally, as shown, the inner faces of the complementary body sections 8 are provided with vertical saw slits 33 at about 2-inch intervals to allow water introduced into

the trough at the top of the body to flow down past the heating element stretches and permeate the entire body of the unit.

The frame 7' employed in the FIG. 5 embodiment of the invention also embraces only bottom and opposite side edges of the body. It differs from the frame previously described, however, in that it is comprised of complementary frame halves 34, one for each body section 8. The confronting edges of the frame halves substantially lie in the plane of the space between the body sections, and they are notched to receive the bends 32 of the heating element. A beading 35 of a soft plastic material, such as "Plastisol," can be applied to said confronting edges and brought into abutting engagement, as shown, to prevent water from leaking out of the bottom and sides of the frame. The frame sections can be held assembled on the body of the unit with the beading 35 on their mating edges in firm sealing engagement, by means of spring clips 36, two on each side edge of the frame. The plastic beading can either be omitted from the bottom edge portions of the frame to allow excess water to drain out of the unit; or the bottom portion of the frame can be provided with a port, not shown, for drainage purposes.

When the heating element is connected with a source of current, it heats up water in contact with it as well as the walls of the honeycomb cells. This heat can be employed not only to substantially promote vaporization for humidification, but to also overcome the cold blast effect of air issuing from the evaporator unit.

FIG. 7 discloses another embodiment of the invention which is similar to that seen in FIGS. 5 and 6 except that a metal duct 37 is substituted for the electrical heating element, to enable a heated fluid medium to be circulated through the duct in indirect heat transfer relation to the surfaces of the evaporator body. Hence the heating duct 37 is also able to promote vaporization and thereby increase the efficiency of the unit for humidification purposes. The duct, of course, can have a number of parallel stretches like those of the heating element 30, connected by headers (not shown) at their opposite ends, or joined by bends such as those seen in FIG. 5.

It is a feature of this invention that the unit shown in FIG. 7 can also be used advantageously as a condenser for refrigerant gases circulated through the duct 37. It will then utilize indirect heat transfer between hot gas in the duct and cooling air blown through the honeycomb cells, as well as the cooling effect achieved as moisture evaporates from the surfaces of the duct and the walls of the honeycomb cells. This cooling effect will be the more pronounced because vaporization is speeded by the heat given up to the evaporator body from the gases circulating through the duct.

One of the outstanding features of the evaporator units of this invention, and especially those of the internally heated embodiments (FIGS. 5, 6 and 7) is that the absorptive media provided by the complementary honeycomb body sections is readily replaceable, at very low cost, whenever accumulations of calcium, magnesium and other minerals on its surfaces seriously detracts from its efficiency.

Another important feature, especially when the evaporator unit of this invention is used as a cooler, is its economical but efficient use of water. This makes it extremely desirable in areas where water is scarce. Water need only be supplied to the absorptive body at the same rate as it is evaporated therefrom, to efficiently maintain the cooling effect upon a heated fluid medium circulated through the duct within the body of the unit.

From the foregoing description, together with the accompanying drawings, it will be apparent to those skilled in the art that this invention provides an inexpensive evaporator unit which is ideally suited for use in humidifiers or in coolers for fluids such as refrigerant gases, and which unit features complementary honeycomb body sections of absorptive material that are readily replaceable at low cost.

What is claimed as my invention is:

1. An evaporator unit, characterized by:

(A) an upright body comprising a pair of closely adjacent body sections each having a multiplicity of closely spaced honeycomb cells substantially registering lengthwise with those of the adjacent body section and opening to the opposite faces of the body so that air can be circulated successively through the cells of one section and then through the cells of the adjacent section, said body sections being comprised of absorptive material having a tendency to become supple when wet;

(B) spacer means between the body sections enabling water to be introduced into the body so that the cell walls can be permeated thereby and water vapor can be transferred to air flowing through the cells, said spacer means comprising the opposite elongated substantially parallel stretches of a U-shaped cord interposed between and bonded to the adjacent inner faces of the body sections and to hold the same in slightly spaced apart relation, whereby water can be introduced into the body from its top through the space between the body sections, the bight of said U-shaped cord being accessible at the exterior of the body to serve as a handle;

(C) and a coating of substantially unyielding water impervious material on those edges of the cell walls that define said opposite faces of the body, to lend rigidity to the body without impairing the absorption properties of the cell walls inwardly of said body faces.

2. An evaporator unit, characterized by:

(A) an upright body having opposite faces, and through which air can be passed from one of said faces to the other;

(B) said body comprising a pair of slightly spaced apart substantially identical body sections having inner and outer faces, one body section being upstream from the other in the direction of air flow through the body;

(C) each body section being

(1) comprised of an untreated highly absorptive water saturable sheet material having a tendency to become supple when wet,

(2) and having a multiplicity of elongated closely adjacent honeycomb cells, with the cells of said sections oriented to allow air to be circulated serially through the cells of the upstream and downstream body sections;

(D) a coating of substantially unyielding water impervious material on the extreme edges of all the cell walls at said outer faces of the body sections, to stiffen and reinforce the same without in anywise impairing the water absorptive properties of the uncoated cell walls inwardly of said faces;

(E) spacer means confined between the body sections and extending across their inner faces at a plurality of locations to establish said slightly spaced apart relation of the body sections, and thereby enable water to flow downwardly into the interior of the body from its top, through the space between the body sections, to wet the cell walls;

(F) and means holding the body sections together in said spaced relation.

3. The evaporator unit of claim 2, further characterized by:

(A) said holding means including a U-shaped frame in which the body is mounted, said frame being open at its top and having a bottom member embracing a bottom edge portion of the body, and having upright side members embracing opposite side portions of the body;

(B) and the tops of said body sections comprising pieces of said sheet material that converge downwardly toward the space between the body sections to thereby serve as a trough in directing water poured onto the tops of the sections into the space therebetween.

4. The evaporator unit of claim 2, wherein said spacer means comprises duct means through which a gaseous medium can be circulated and in which said medium can be condensed in consequence of the cooling effect produced by evaporation of water from the wall surfaces of the honeycomb cells.

5. The evaporator unit of claim 2, wherein the spacing of said body sections is established by heating means confined between the sections and operable to promote vaporization of water from the surfaces of the sections.

6. The evaporator unit of claim 4, wheerin said heating means comprises an electrical heating element.

7. The evaporator unit of claim 4, wherein said heating means comprises a duct through which a fluid heating medium can be circulated.

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U.S. Cl. X.R.

261—95, 154