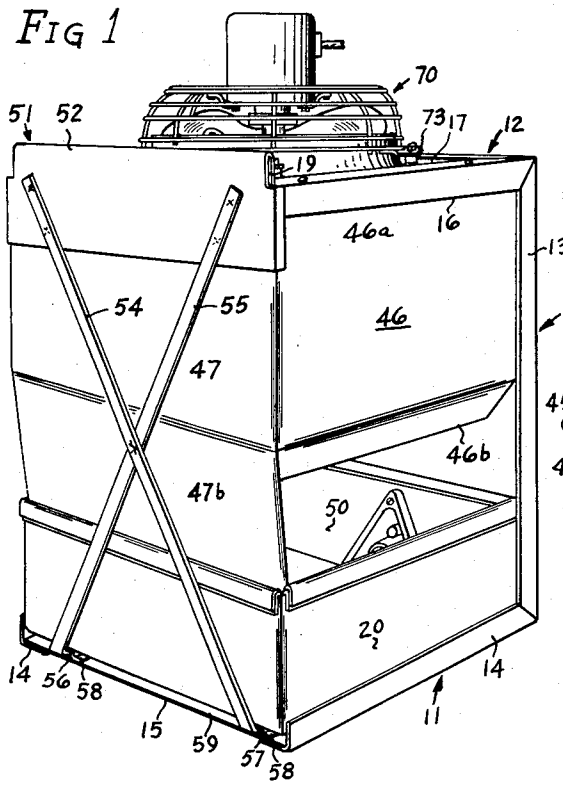
Sept. 29, 1959 G. W. MEEK 2,906,512

COOLING TOWERS

Filed July 23, 1956 2 Sheets-Sheet 1

FIG 1



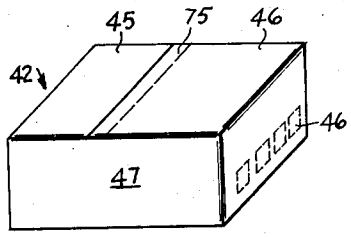


FIG. 7

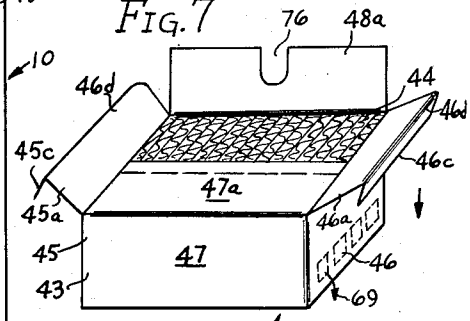


FIG. 8

FIG. 2

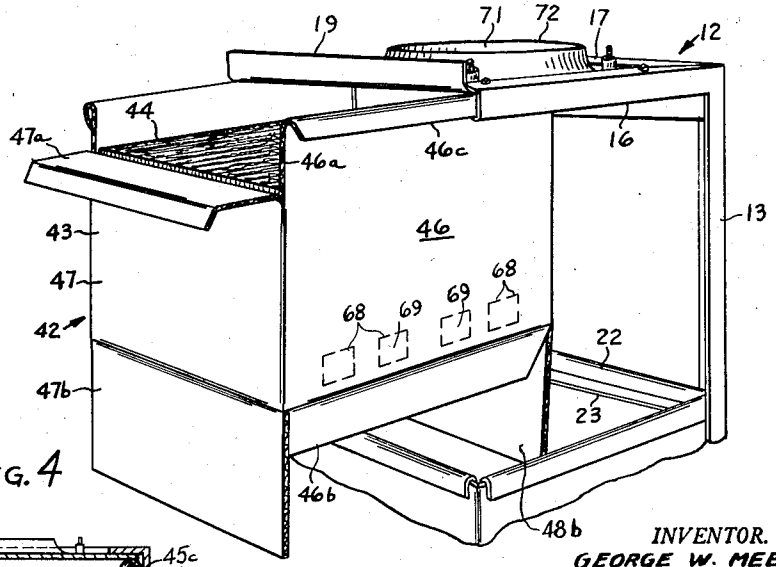
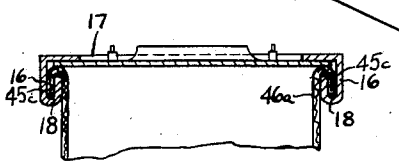


FIG. 4



INVENTOR.
GEORGE W. MEEK

BY

ATTORNEY

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FIG. 5

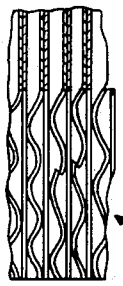


FIG. 6

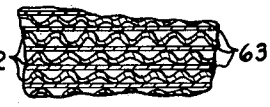
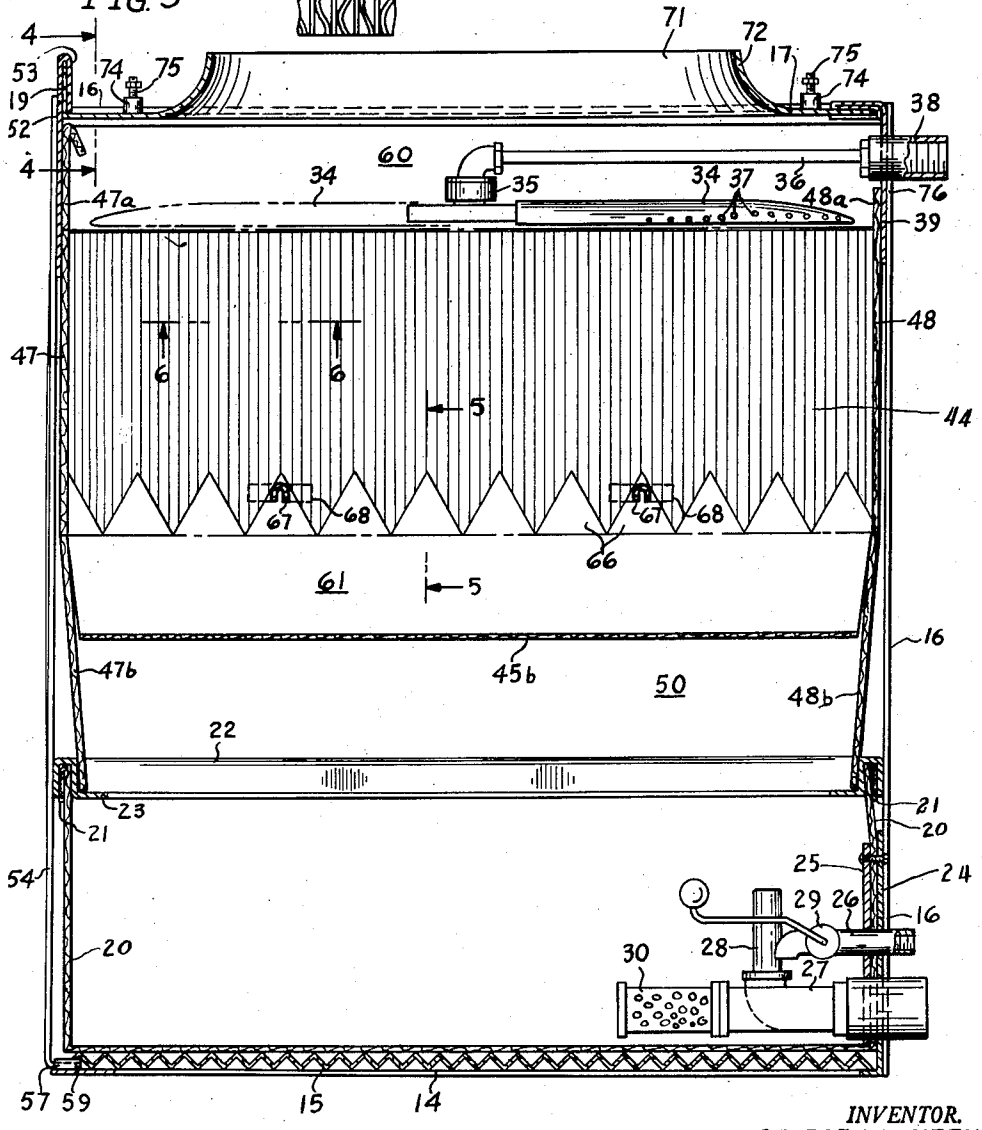


FIG. 3



INVENTOR.
GEORGE W. MEEK

BY Eric G. Greenson

ATTORNEY

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2,906,512

COOLING TOWERS

George W. Meek, Pelham, N.Y., assignor to Carl Munters & Company, Danderydavagen, Stockholm, Sweden, a partnership of Sweden

Application July 23, 1956, Serial No. 599,443

9 Claims. (Cl. 261—24)

The present invention relates to gas and liquid contact apparatus and more particularly to improvements in cooling towers for cooling water by evaporative cooling.

Cooling towers are old and well known and generally comprise an enclosing housing having a liquid distributing means adjacent the top, a sump tank at the base and a packing between the liquid distributing means and sump tank. Water from the liquid distributing means flows downwardly through the packing by gravity and air flows upwardly through the packing by natural draft or by an induced or forced draft fan.

The packing provides an extended surface over which the water flows in thin films or sheets for contact by the air to promote evaporation. The packing may take many forms such as wooden strips stacked in spaced relation in the tower, spaced screens, and sheets of rigid or flexible material or bulk material such as mineral wool are among numerous other materials that have been used. Such packing material is either mounted or stacked in the tower through its open top or in a removable side and requires considerable time to service and repair.

Such conventional cooling towers are usually composed of wood which is subject to rot, or of metal which is subject to corrosion. The conventional towers are inherently heavy and bulky and expensive to manufacture and transport. They also require considerable maintenance time to repair, paint, clean and remove scale and other foreign materials. Also, they are apt to be extensively damaged when a freeze-up occurs.

One of the objects of the present invention is to provide a cooling tower of extremely small dimensions and light-weight construction and composed of materials which substantially reduce its cost of manufacture and transportation over conventional towers of the same capacity.

Another object is to provide a cooling tower of the type indicated which avoids all problems of maintenance due to corrosion.

Anothr object is to provide a packing material in interchangeable package units which may be economically replaced when fouled with mineral scale or other foreign matter, to simplify maintenance.

Another object is to provide a packing assemb'y in a unitary self-contained package adapted to be easily and quickly mounted on or removed from an open skeleton frame as a unit and providing the enclosing side walls of the tower.

Still another object is to provide a cooling tower of the type indicated which reduces noise, gives more reliable operation and uniform capacity over long periods of time than conventional towers and reduces the possibility of damage due to freeze-up.

These and other objects will become more apparent from the following description and drawings of one embodiment of the invention in which like reference characters denote like parts throughout the several views.

It is to be expressly understood, however, that the drawings are for the purpose of illustration only and not a definition of the limits of the invention, reference being had for that purpose to the appended claims.

In the drawings:

Figure 1 is a perspective view of a cooling tower incorporating the novel features of the present invention;

Figure 2 is a perspective view of the cooling tower showing the open skeleton frame and the manner of mounting a package of packing material as a unit in the frame;

Figure 3 is a sectional view through the tower illustrated in Figure 1 and showing the manner in which the wrapper or carton for the packing material forms the side walls of the tower;

Figure 4 is a transverse sectional view taken on line 4—4 of Figure 3 to show the interlocking flanges for supporting the package of packing on the frame;

Figure 5 is a vertical sectional view taken on line 5—5 of Figure 3 to show the form of the corrugated packing sheets in side elevation;

Figure 6 is a transverse sectional view taken on line 6—6 of Figure 3 to show the parallel cells formed by the corrugated sheets of packing material;

Figure 7 is a perspective view of the package of packing material with the flaps folded to closed position; and

Figure 8 is a view similar to Figure 7 showing several of the flaps at the top of the carton package opened prior to mounting the package in the frame of the tower.

In general, the cooling tower of the present invention comprises a frame having sump tank mounted in its base, a liquid distributing device supported by the frame above the sump tank and with a packing material positioned between the liquid distributing device and sump tank. In accordance with one aspect of the invention, the packing elements, such as sheets of chemically treated corrugated paperboard are assembled in a wrapper such as a chemically treated paperboard carton to provide a self-contained package of packing adapted to be easily and quickly applied to or removed from the frame as a unit. In another aspect of the invention, the carton of packing material is mounted on an open skeleton frame and forms the side walls of the tower. Opposite pairs of flaps extend upwardly from the package to the top of the frame to provide a liquid distributing chamber enclosing the liquid distributing device above the top of the packing. One pair of opposed flaps depend from the package into the sump tank and another pair of opposed depending flaps are folded inward'y toward each other at an angle to provide a pair of air inlet openings below the packing at opposite sides of the tower. The side walls of the packing carton then form the side walls of the tower and a fan mounted on the top of the skeleton frame draws air through the air inlet openings upwardly through the parallel cells formed by the corrugated sheets within the carton frame.

The embodiment of the invention illustrated in the drawings comprises an open skeleton frame 10 having a bottom portion 11, a top portion 12 and upright stanchions 13 extending upwardly from the base to the top portions at one side. The base portion 11 of the frame comprises angle sections 14 on two sides and a corrugated metal plate 15 extending between and supported on and attached to the horizontal flanges of the angle section, see Figure 3. The top portion 12 of the frame also comprises angle sections 16 on two sides with a plate 17 extending therebetween and attached to the horizontal flanges of the angle sections. Stanchions 13 extend upwardly from the corners of the base portion 11 at one side to one end of the angle sections 16 of the top portion 12 to support the latter from the base portion,

The angle sections 16 of the top portion of the frame are of channel shape to provide a vertically arranged flange 18 projecting upwardly therefrom. One end of the plate 17 is bent upwardly to provide a vertical flange 19. Preferably, the angle sections and plates of the skeleton frame are made of a light non-corrosive metal such as aluminum to reduce the weight of the frame to a minimum.

Sump tank 20 is mounted on the corrugated plate 15 of base portion 11 of the frame 10 to support the bottom of the sump tank over its entire area, see Figure 3. The sump tank may be composed of any suitable non-corrosive material but preferably is composed of a heavy gauge fibre board to give it the required rigidity to hold water but flexible enough to expand if water therein freezes, without rupturing the material. The fibre board material may be impregnated with a plastic and/or coated with a wax to render it waterproof and weatherproof. A suitable plastic resin is one derived from phenols and the wax may be of the microcrystalline type. As illustrated in Figure 3 of the drawings, the upper edge of the sump tank 20 is reinforced by folding back the upper edge portion 21 of the walls of the sump and enclosing the folded-back portion in an inverted channel shaped rim 22 having an inwardly directed flange 23, see Figure 3.

A reinforcing structure is provided on one side wall of the sump tank 20 and consists of an outer plate 24 adapted to rest on the horizontal flanges of the angle sections of the frame and a plate 25 in the sump tank 20. Inner plate 25 is connected to the outer plate 24 by bolts which extend through and clamp the wall of the tank therebetween. The plates 24 and 25 have openings therein for supporting a feed water pipe 26, a drain pipe 27 and an overflow pipe 28. A float operated valve 29 is provided adjacent the end of the feed water pipe 26 to supply make-up water to the tower as required. A filter 30 in the tank 20 is connected to the drain pipe 27 which, in turn, is adapted to be connected to a pump (not shown) at the exterior of the tower for delivering water to the place where it is to be used. The overflow pipe 28 projects upwardly to a level as determined by the position of the float of valve 29 to continually bleed small quantities of water from the tower to prevent the concentration of mineral solutes.

The liquid distributing device is in the form of arms 34 extending radially from a centrally located head 35 which, in turn, is supported by a pipe 36. Arms 34 have orifices 37 at opposite sides, respectively, for spraying water in a plurality of streams and rotating the arms by the reactive force. A coupling 38 is provided at the other end of the pipe 37, and the coupling, head 35 and liquid distributing arms 34 are all supported by a metal flange plate 39 hung from one side of plate 17 on the top portion 12 of the frame.

The self-contained package 42 of packing material is detachably mounted on the top portion 12 of the skeleton frame 10 between the liquid distributing arms 34 and sump tank 20. As illustrated, the package 42 comprises a wrapper 43 in the form of a carton or shipping case containing the packing material 44 therein. The package 42 has opposite pairs of side walls 45, 46 and 47, 48 with flap extensions 45*a*, 46*a* and 47*a*, 48*a* projecting upwardly above the packing 44 and flap extensions 45*b*, 46*b*, and 47*b*, 48*b* depending below the packing. The upper ends of the flap extensions 45*a* and 46*a* of walls 45 and 46 are folded back on themselves to provide depending flanges 45*c* and 46*c* which interlock with the upwardly projecting flanges 18 on the top frame portion 12 to hang the packing package on the frame, see Figures 2 and 4. The other pair of flap extensions 47*a* and 48*a* of the package walls 47 and 48 project upwardly between the extensions 45*a* and 46*a* to the top plate 17 of the frame. The depending wall extensions 47*b* and 48*b* at two opposite sides of the package 42 depend below the packing 44 into the sump tank 20 and the extensions 45*b* and 46*b* depending from the other pair of opposite sides are folded inwardly toward each other at an acute angle to the sides of the package to provide air inlet openings 50.

A detachable frame section 51 overlies the open side of the frame 10 to hold the package 42 of packing material in position on the frame. The detachable frame section 51 comprises a top plate 52 having a depending flange 53 at its upper edge which interlocks with the upstanding flange 19 on the top frame portion 12. Cross struts 54 and 55 are attached to and depend from the plate 52 and have right angular feet 56 and 57 at their lower ends which interlock with brackets 58 on a bar 59 extending across the bottom portion 11 of the frame. The frame section 51 may be easily and quickly detached from the skeleton frame 10 by withdrawing the feet 56 and 57 from the brackets 58 and then lifting the frame section vertically to release the flange 53 from the flange 19 of frame section 12.

Thus, the side walls 45, 46, 47 and 48 of the package 42 in addition to supporting and enclosing the packing material 44, form the side walls of the tower to confine the flow of liquid and air therethrough. The upwardly projecting wall extensions 45*a*, 46*a*, 47*a* and 48*a* form a closed chamber 60 above the packing 44 in which the arms 34 of the liquid distributing device rotate to distribute water onto the top of the packing. The depending extensions 45*b*, 46*b*, 47*b* and 48*b* also define a chamber 61 for confining water flowing from the packing 44 to cause it to flow to the sump tank 20 and confining the air entering through the air inlet openings 50 to cause it to flow upwardly through the packing. In its preferred embodiment, the wrapper or carton 43 is composed to a fibre board such as paper either impregnated with a plastic material, such as a phenol formaldehyde resin coated with microcrystalline wax, or both, to render it waterproof and weatherproof.

While the packing material may take other forms, in a preferred embodiment, it is composed of alternate sheets of corrugated and flat paper 62 and 63 to provide a plurality of vertically arranged parallel cells 64, see Figure 6. The sheets are impregnated with a suitable plastic, such as a phenol resin or melamine, to render them wettable by the water while at the same time retaining the strength required to support themselves in the packing assembly. Such a packing is the invention of Carl G. Munters as described and claimed in application Serial No. 592,786, filed June 21, 1956, now Patent No. 2,809,818, dated October 15, 1957. The packing is of light weight and has an extremely large surface area per unit of volume. Preferably the height of the corrugations range between ⅛ and ⅜ of an inch. With such small cross sectional areas, the water tends to cling to the bottom of the cells 64 by surface tension. To avoid such hold up of the flow of water from the packing, the lower edges of sheets 62 and 63 are notched at 66 to provide a vertical extension at the outlet ends of the cells and inclined surfaces along which the water flows away from the cells and drip from the packing to prevent bridging of the outlet ends of the cells by surface tension of the water. The assembled packing is supported in the carton 43 by cross strips 67, see Figure 3, engaging the sheets 62 and 63 in the notches 66 with the ends of the strips attached to the side walls 45 and 46 of the carton. Preferably the cross strips 67 are of folded paper board impregnated with a resin and/or wax and having right angular tabs 68 at their ends attached to the side walls of the carton by staples 69.

A propeller type fan unit 70 is detachably mounted on the top plate 17 on the top portion 12 of the frame 10. Plate 17 has a circular opening 71 therein and an upwardly directed flange 72 surrounding the opening to provide a shroud ring surrounding the propeller of the fan. The fan unit 70 overlies the circular opening 71

in the plate 17 and has brackets 73 at its edges mounted on rubber bushings 74 surrounding studs 75 to which the brackets are clamped.

A feature of the invention is the provision of a self-contained package 72 of the packing material which may be easily and quickly inserted into or removed from the skeleton frame 10. In this phase of the invention the wall extensions 45*a*, 46*a*, 47*a* and 48*a* constitute closure flaps of the carton in which the packing material is shipped. The flaps 45*b* and 46*b* are folded inwardly toward each other and the opposite pair of flaps 47*b* and 48*b* are then folded inwardly toward each other over the previously folded flaps and detachably sealed to each other to provide a bottom to the carton. The sheets 62 and 63 of packing material are then assembled in the carton on the cross strips 67 after which the flaps 47*a* and 48*a* are folded inwardly toward each other, the flaps 45*a* and 46*a* folded over the previously folded flaps and the seam temporarily closed with adhesive paper or the like to provide a shipping unit. It will be noted from Figure 7 that the flaps 45*a* and 46*a* are scored as indicated at 75 to facilitate folding the end portions to form the interlocking flanges 45*c* and 46*c*. Also, flap 48*a* has a notch 76 to accommodate the coupling 38 on pipe 36 of the liquid distributing means.

To insert the package 42 of packing material in the skeleton frame 10, it is merely necessary to open the flaps 45*a* and 46*a* from the position in Figure 7 to that illustrated in Figure 8. The package unit 42 is then slid into position of the skeleton frame in the manner illustrated in Figure 2 with the flanges 45*c* and 46*c* interlocking with the flanges 18 on the top portion 12 of the frame. The other flaps 47*a* and 48*a* then are folded to a vertical position, the depending flaps 47*b* and 48*b* folded vertically into the sump tank and the flaps 45*b* and 46*b* folded inwardly toward each other at an acute angle as illustrated in Figure 1. The frame section 51 is mounted on the open end of the skeleton frame by sliding the top plate 52 downwardly onto the upstanding flange 19 on the plate 17 of the frame and inserting the feet 56 into the brackets 58. The frame section 51 then holds the packing unit 42 in position on the frame.

Another feature of the invention is the provision of a self-contained package unit 42 of the packing material as illustrated in Figure 6 which is adapted to nest in the top of the sump tank 20 for shipment in the frame 10. For this purpose, the plate 17 with the fan unit 70 mounted thereon is turned upside down from the position illustrated in Figure 1 and attached to the angle sections 16 of the top portion 12 of the frame. Thus, the entire cooling tower unit may be shipped as a single unit.

One of the principal advantages of applicant's cooling tower resides in the extremely compact dimensions of the tower and the reduction in its weight. Because of the construction of the skeleton frame 10 from light weight noncorrosive metals and the paper packing material and paperboard wrapper, the weight is reduced as much as one-eighth of conventional cooling towers having the same capacity. Because of the use of alternate sheets of corrugated and flat paper arranged in closely spaced relationship, a large surface area is obtained per unit of volume of the packing material. This further decreases the overall dimensions of the tower and the weight thereof. For example, a cooling tower made in accordance with applicant's invention, having a capacity equal to the cooling effect of three tons of ice a day, is 20 inches wide, 20 inches deep and 30 inches high, and weighs approximately one hundred pounds. A cooling tower for producing a capacity corresponding to the melting of 7½ tons of ice is 30 inches wide, 30 inches deep and 30 inches high and has a weight corresponding to the increased volume.

The cooling tower operates in the conventional manner by the fan unit 70 drawing air through the air inlet openings 50 at opposite sides of the tower and upwardly through the packing 44 and then discharging it from the top of the tower. Water supplied through the pipe 37 to the liquid distributing arms 34 is sprayed over the top of the packing 44 and flows down on the walls of each cell 62 in thin films for direct contact with the air flowing upwardly through the cells. Part of the water evaporates into the air which produces a cooling effect on the remainder of the water approximately equivalent to one thousand B.t.u. for every pound of water evaporated. The cooled water is withdrawn from the sump tank 20 through the drain pipe 27 by a pump (not shown) which delivers the water to the apparatus to be cooled and returns it to the pipe 37 leading to the liquid distributing device 34. Make-up water is supplied by the float operated valve 29 through the feed pipe 26 connected to a water main. A predetermined fixed amount of water is continuously bled from the sump tank 20 through the overflow pipe 28 to prevent the concentration of minerals in the water.

It will now be observed that the present invention provides a cooling tower which is of extremely simple and compact construction and considerably more economical to manufacture and transport than conventional towers of the same capacity. It will further be observed that the present invention provides a cooling tower which avoids all problems of maintenance due to corrosion and reduces maintenance to a minimum for all other purposes. It will still further be observed that the present invention provides a packing assembly in a self-contained package adapted to be easily and quickly mounted on or removed from an open skeleton frame as a unit with the package itself providing the side walls of the tower.

While a single embodiment of the invention is herein illustrated and described, it will be understood that modifications may be made in the construction and arrangement of elements without departing from the spirit or scope of the invention. Therefore, without limitation in this respect, the invention is defined by the following claims.

I claim:

1. A cooling tower comprising a skeleton frame, a sump tank mounted on the frame, liquid distributing means supported on the frame as above the base, a gas and liquid contact packing unit between the liquid distributing means and sump tank, said packing unit comprising packing material assembled in a paper board carton, said carton having opposed pairs of flaps extending from the sides at the top and bottom, one pair of top flaps interlocking with the frame to support the packing material below the liquid distributing means, one pair of bottom flaps projecting into the sump tank and the other pair of bottom flaps being inclined inwardly toward each other to provide air inlet openings between the sump tank and packing material.

2. A cooling tower comprising a frame of skeleton construction having a base portion, a top portion and at least one upright stanchion supporting the top portion from the base portion, a sump tank supported by the base portion, liquid-distributing means in the form of a carton of packing material supported by the frame above the sump tank, the carton having opposed pairs of flaps extending from its sides at the top and bottom, one pair of the top flaps engaged with parts of the top portion of the frame, the other pair of top flaps extending from the sides of the carton to the top portion of the frame, one opposed pair of bottom flaps extending into the sump tank, the opposite pair of bottom flaps being inclined inwardly toward each other to provide air inlets between the sump tank and packaging material, and a fan mounted on the top portion of the frame for circulating air through the packing material.

3. A cooling tower in accordance with claim 2 in which the means for supporting the liquid distributing means on the frame is a plate depending from the top portion

of the frame, and one of the flaps at the top of the carton of packing material being notched to accommodate the liquid distributing means.

4. A cooling tower in accordance with claim 2 in which the carton of packing material is adapted to nest in the sump tank, and the fan is adapted to be inverted on the top portion of the frame for transportation in the frame as a self-contained unit.

5. In a cooling tower, a skeleton frame, a contact unit mounted therein, said contact unit comprising a carton containing packing material, the carton having upwardly and downwardly-extending flap extensions, the upward flap extensions forming a walled passage above the packing, and the downward flap extensions forming a walled passage extending below the packing, said flap extensions normally forming the closure flaps for the carton when the carton and its contents are out of the frame.

6. In a cooling tower a frame having a fan at the top and a sump tank at the bottom, a packing interposed between the fan and sump tank, said packing consisting of a carton filled with packing material, said carton having foldable flaps at the top by which it is hung in the frame and which flaps form a walled passage between the packing in the carton and the fan, the carton having flaps at its bottom, which bottom flaps co-operate in the formation of a walled passage between the lower end of the packing and the sump tank.

7. A cooling tower comprising a frame, a sump tank supported by the frame, liquid-distributing means supported by the frame above the sump tank, gas and liquid contact packing material assembled in a self-contained package consisting of the packing material housed within a carton having flaps extending from one pair of its opposed sides, a demountable frame section interlocking with the frame to hold the package in place on the frame, and interengaging means on the frame and flaps to hang the package on the frame and enable the package to be slid in and out of the frame as a unit.

8. A cooling tower comprising a frame having flanges, a sump tank supported by the frame, liquid-distributing means supported by the frame above the sump tank, gas and liquid contact packing material assembled in a self-contained package consisting of the packing material housed within a carton having opposed pairs of flaps extending from the sides at the top and bottom, one pair of the flaps interlocking with the flanges on the frame, the other pair of top flaps extending to the top portion of the frame, one opposed pair of bottom flaps extending into the sump tank, and the opposite pair of bottom flaps being inclined inwardly toward each other to provide air inlets between the sump tank and the packing material, the package being supported on the frame in a manner to enable it to be slid in and out of the frame as a unit.

9. A self-contained package of packing material for a cooling tower comprising a carton confining the packing material, said carton having a plurality of hinged flaps for closing the top and a plurality of hinged flaps forming closure means for the bottom of the carton, the top flaps being capable of hinged movement to vertical position to form a walled passage extending above the contents of the carton, a plurality of the top flaps being turned over at their edges to enable said turned-over edges to engage with parts of a supporting frame, and the bottom flaps being foldable downwardly to form a walled passage extending below the packing material, said packing material being serrated at its end facing the bottom of the carton, means extending between opposite walls of the carton below the packing material therein and passing between the serrations thereof for supporting the material and preventing such material from descending downwardly out of the carton when the bottom flaps are folded downwardly to form the walled passage.

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