Jan. 24, 1956 L. T. MART 2,732,190

CROSS FLOW COOLING TOWER HAVING RECYCLING SYSTEM

Filed Sept. 24, 1952 3 Sheets-Sheet 1

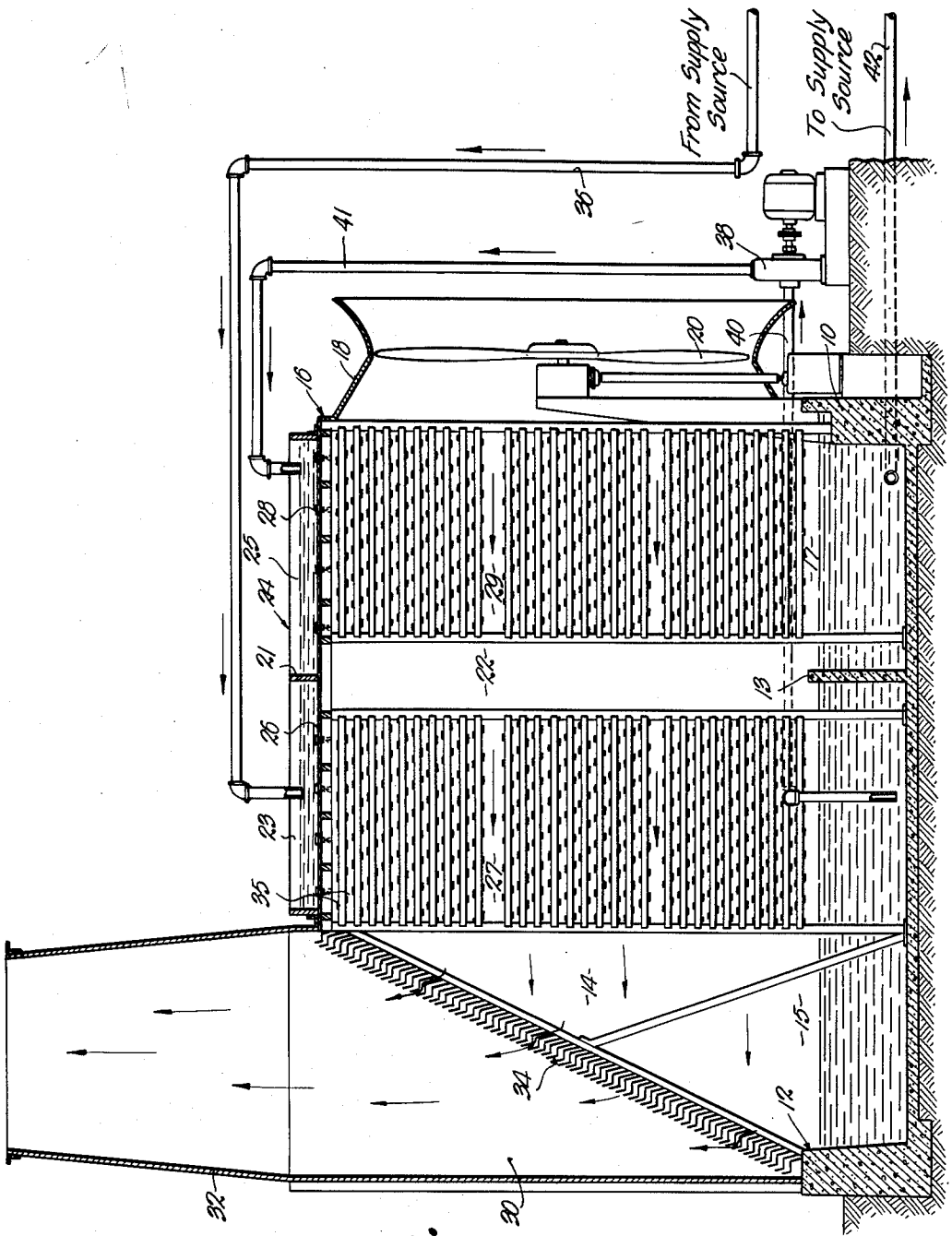


Fig. 1.

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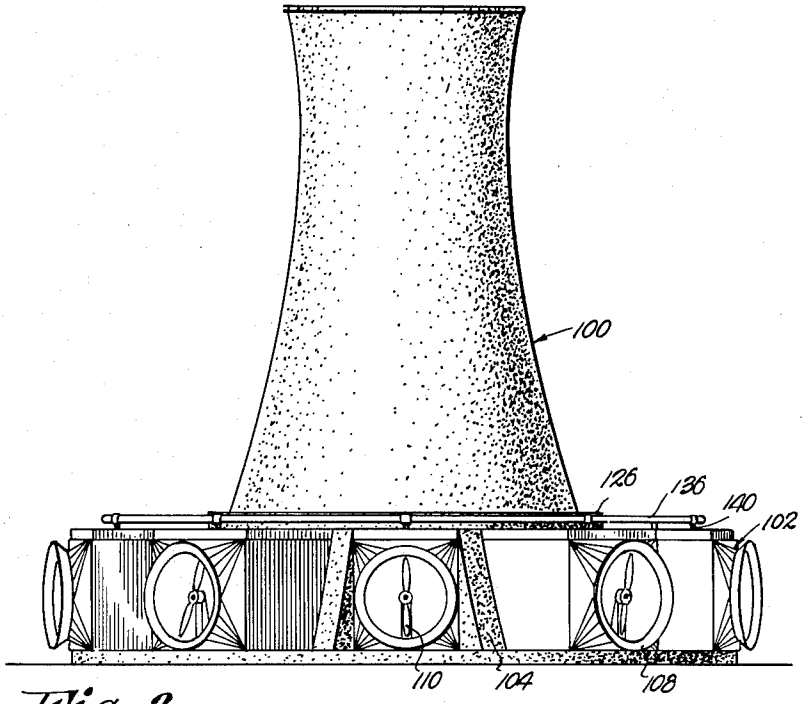


Fig. 2.

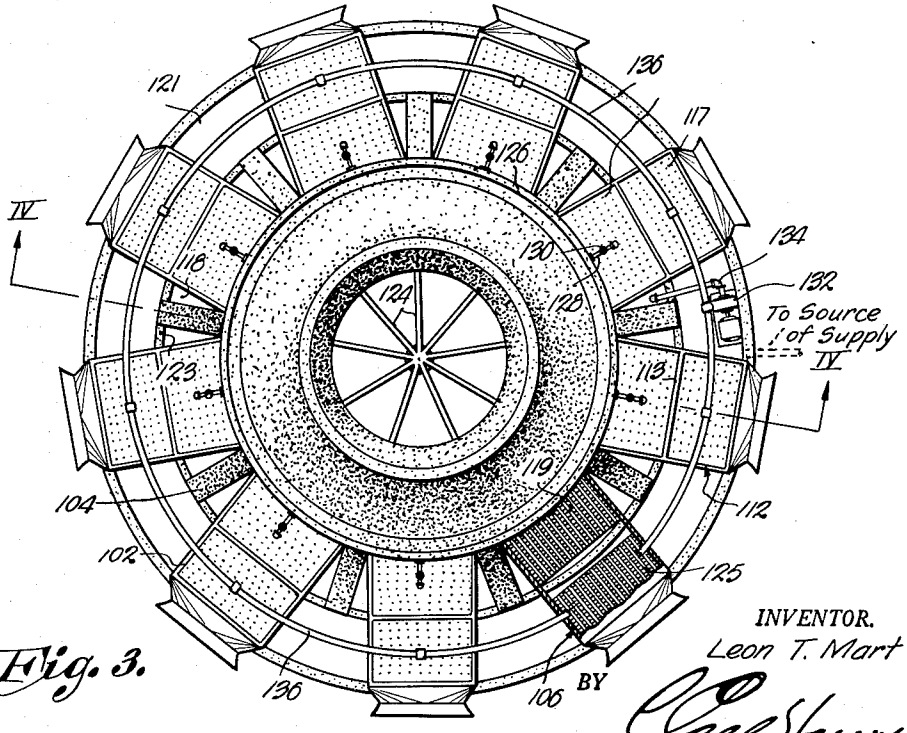


Fig. 3.

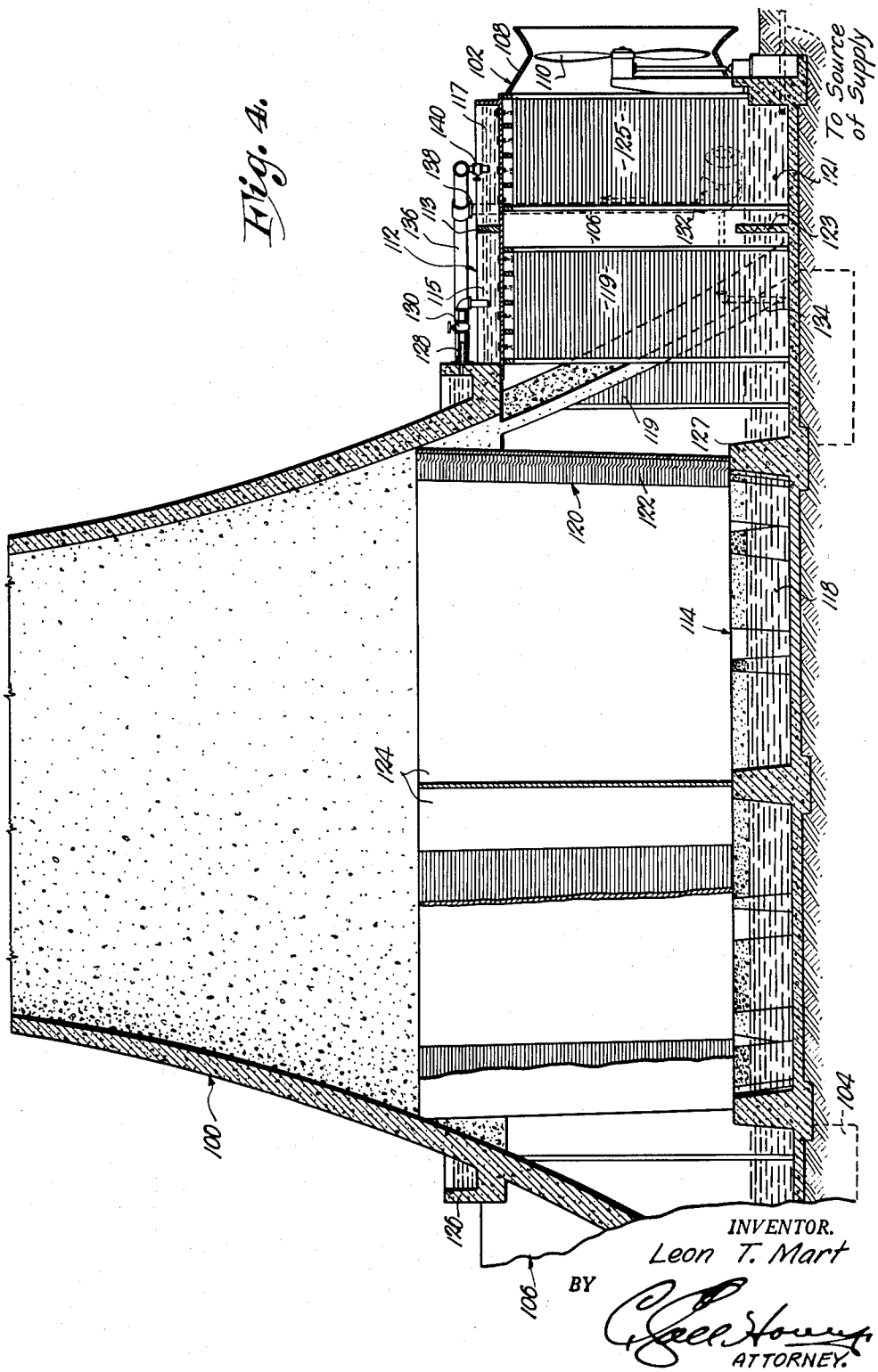
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Fig. 4.



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CROSS FLOW COOLING TOWER HAVING RECYCLING SYSTEM

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Application September 24, 1952, Serial No. 311,227

2 Claims. (Cl. 261—21)

This invention relates to heat exchangers of the so-called cooling tower type where the water is reduced in temperature by a current of air traversing the tower in horizontal paths while the water is dropped vertically through the tower to intersect the air currents.

The primary aim of this invention is to provide equipment of the aforementioned character having means for recycling the water being cooled so that it will pass through the air traversing the splash deck of the cooling tower a number of times, each successive passage of the water through the air being closer to the air intake end of the splash deck than the last passage.

A still further object of this invention is to provide a cooling tower having as a part thereof a splash deck, a number of overhead distribution trays adapted to drop streams of water through the splash deck into underlying catch basins, the accumulated water in a catch basin below one tray being deposited in the tray next closest to the air intake end of the splash deck.

It is an important object of the present invention to provide a cooling method that includes in combination, gravitational flow of liquid to be cooled, cross-flow of artificially produced currents of air for cooling the gravitating liquid, receiving the hot air current and directing the same vertically to a point where the discharged air will not be recirculated, and recirculation of the water through the air streams to progressively cool the same.

Another important aim of this invention is to provide a cooling system for water wherein a common splash deck has successively passed therethrough a number of streams of water to the end that the said streams attain a progressively lower temperature as the air inlet end of the splash deck is approached, and whereby the continuous current of air that is caused to intersect the successive streams, is raised in temperature as the outlet end of the splash deck is approached thereby.

Further aims of this invention will appear during the course of the following specification, having reference to the accompanying drawings wherein:

Figure 1 is a vertical, cross-sectional view through one form of cross-flow cooling tower having a recycling system made pursuant to the present invention.

Fig. 2 is a side elevational view of a cooling tower embodying the principles hereof in another form of the invention.

Fig. 3 is a top plan view of the cooling tower shown in Fig. 2, parts being broken away for clearness; and

Fig. 4 is a fragmentary, enlarged, cross-sectional view taken on line IV—IV of Fig. 3.

This is a continuation-in-part of my co-pending application Serial No. 245,040, filed September 4, 1951.

The component parts of the cooling tower shown in Fig. 1 of the drawings include a supporting foundation **10** for all of the structural parts of the tower and preferably formed for convenience and cheapness of construction to present a cold water-receiving sump, broadly designated by the numeral **12**. A partition **13** divides sump **12** into an inner catch basin **15** and an outer catch basin **17**.

A hollow housing **14** has one end **16** thereof in substantially full and complete communication with an air inlet tube **18** that in turn receives a rotatable fan **20** for creating and forcing the flow of artificial currents of air in the direction indicated by the arrows in Fig. 1 of the drawings. Fan **20** and a suitable prime mover for driving the same (not shown), are rigidly mounted on the foundation **10** and this entire power unit is thereby rendered accessible for maintenance, repair and observation of its operation at all times.

It is noted that the vertical height of the inlet tube **18** is substantially the same as the height of a fill assembly broadly designated by the numeral **22** and disposed within the housing **14**, and likewise, the width of the tube **18** at the innermost end thereof is substantially the same as the width of the assembly **22**.

The outwardly-flared inlet end of tube **18** operates to render fan **20** fully effective in moving a maximum volume of air without loss of air movement at any point throughout the length of blades **20** or throughout the full diameter of tube **18**.

Housing **14** is provided with an opening at the top thereof for receiving a relatively shallow, hot liquid-receiving basin **24** that is provided with a bottom wall **26** and a partition **21** to present an inner tray **23** and an outer tray **25**, having an area that is substantially coextensive with the cross-sectional dimensions of the fill assembly **22** which it overlies. Bottom wall **26** is provided with a plurality of liquid discharge perforations or nozzles **28** for free passage of water from the basin **24** to the two sections **27** and **29** of fill assembly **22** through action of gravity. A distribution deck, not shown, may be utilized between the wall **26** and the uppermost end of the fill assembly **22** for assuring even flow of the liquid over the entire cross-sectional area of the assembly **22** if desired.

It is furthermore appreciated that the basin **24** may be provided with a cover to overcome adverse effects of the sun upon the water, such as formation of algae, but its elimination, as illustrated in the drawing, has no effect upon the overall operation of the cooling tower itself.

That end of the housing **14** opposite to end wall **16** thereof extends beyond the fill assembly **22** and presents a housing portion **30** for receiving the forced currents of air from the assembly **22** and directing the same upwardly above the uppermost level of basin **24**. Housing portion **30** is open at the lowermost end thereof and in direct alignment with a portion of the sump **12** that extends beyond the fill assembly **22**. The uppermost end of the housing portion **30** is likewise open and communicates with a tubular stack **32** that may be of any suitable height, as hereinafter more fully described, to effectively discharge the air vertically to a point where the same is not likely to recirculate into the tube **18** and thence through the fill assembly **22**.

A drift eliminator **34** is provided within the housing portion **30** for removing water that is entrained within the air emanating from the fill assembly **22**, such eliminator **34** being coextensive in width with the fill assembly **22**. Eliminator **34** may be of conventional character in that the same includes a plurality of inclined louvers and the entire eliminator **34** extends at an angle from foundation **10** upwardly toward the uppermost end of the fill assembly **22**. Drift eliminator **34** therefore, intersects the path of travel of the air currents as indicated by the arrows in Fig. 1 of the drawings, and the water removed from such air is free to gravitate into the underlying basin of sump **12**.

The fill assembly **22** is preferably made in its entirety from wood (although other materials have and are being used) and includes a plurality of spaced-apart layers **35**

of horizontal slats, presenting free passages for the flow of air from the tube **18** toward the housing portion **30**. The slats of each layer, are in staggered relationship to the slats of the layers therebelow, thereby presenting a serpentine path of travel for the liquid emanating from the basin **24** and gravitating to the underlying basin of sump **12**.

Liquid to be cooled is fed from a point of use, directly to the tray **23** by a pipe **36**. Liquid emanating from the section **27** of the assembly **22** is collected by the catch basin **15**, as is the liquid which is removed from the air by the eliminator **34**. A pump **38** has its inlet in communication with the catch basin **15** by a pipe **40**, and discharges into the tray **25** by means of a pipe **41**. The liquid collected by the basin **17** from the section **29** is redirected to a point of use by a pipe **42**.

Figs. 2 to 4 inclusive of the drawings, illustrate the way in which the principles hereof may be embodied in a composite assembly having a stack **100** common to a plurality of units.

Heat exchange apparatus, in England particularly, and in other countries foreign to the United States, differs in form and in operation from the broad principles above set forth. The high cost of electric power and the ready availability of concrete have resulted in use of natural draft principles, and accordingly, the construction of relatively large, parabolical stacks **100**, so formed to obviate the necessity of using power to produce a constant flow of currents of air. These stacks average approximately 200 to 280 feet in height, with a range of between 80 and 340 feet, and with base diameters ranging proportionately from 50 to 300 feet. They therefore, necessarily embody expensive structural parts and workmanship.

Accordingly, conversion today from natural draft principles to cooling towers using power for creating currents of air, with resultant abandonment of such costly structures, would be impractical. However, as shown in Figs. 2 to 4 inclusive, these stacks **100** can be converted to forced draft operation by employing the features hereinabove outlined.

It is proposed that a plurality of side-by-side or spaced, identical units **102** be arranged in an annular row about the base of stack **100**, each unit **102** being substantially the same as that shown in Fig. 1, and disposed either between foundations **104** for stack **100** or outwardly therefrom. Each unit **102** accordingly includes a fill assembly **106**, an air inlet tube **108**, a fan **110**, a hot water basin **112** and a cold water sump **114**.

The basins **112** are each sub-divided by a partition **113**, presenting a pair of trays **115** and **117**. Similarly, the sump **114** includes an inner catch basin **118** common to inner section **119** of the assemblies **106** and to a drift eliminator **120** within stack **100**. An outer, annular catch basin **121**, presented by a partition **123** is common to sections **125** of assemblies **106**.

Eliminator **120** includes a number of sections **122**, one for each unit **102**, and interconnected to present a continuous structure circumscribing the vertical axis of stack **100**. A suitable foundation **127** forming a part of sump portion **118** supports eliminator **120** and the sections **122** thereof may be either vertically disposed or, particularly if the units are disposed outwardly from foundations **104**, inclined similarly to the inclination of eliminator **34** in Fig. 1.

While no reason is apparent for dividing the assemblies **106**, vertical partitions **124** within eliminator **120** are desirable to avoid the adverse effects of wind upon some of the units **102** and entering certain of the tubes **108**.

A horizontal drift eliminator within stack **100** above the top horizontal plane of units **102** may conceivably be used in place of the type of eliminators hereinabove described.

Stacks **100** are commonly provided with an annular, hot water-receiving trough **126**, and discharge spouts **128** are provided in trough **126** for each tray **115** respectively, each spout having a valve **130**.

One or more pumps **132** are provided for removing water from catch basin **118** by means of a pipe **134** and directing the same to a manifold **136** surrounding stack **100**, by means of a discharge pipe **138**. A valved outlet **140** is provided in manifold **136** for each tray **117** respectively.

In both forms of the invention therefore, the hot water is fed from a point of use to the distribution tray next adjacent the air discharge end of the fill assembly or splash deck. It thereupon gravitates through the innermost fill assembly section to the sump basin therebelow and is pumped therefrom to the outermost tray or trays for gravitation to the outermost catch basin from which the cold water is directed to the point of use. The valving permits use of as many units **102** as may be desired, and of course, prevailing winds and other factors will determine whether or not all of the fans **110** are employed simultaneously.

The progressive cooling of the water as the air inlets are approached, raises the efficiency of the heat exchange unit appreciably whether forced or natural draft methods of air movement are employed.

Having thus described the invention what is claimed as new and desired to be secured by Letters Patent is:

1. Structure for the air cooling of water comprising a hollow housing having a portion at one end thereof extending upwardly into a vertical stack discharging above the top of the housing; an air inlet tube at the opposite end of the housing; a fill assembly in the housing between the tube and said portion, and including an inner section and an outer section; a hot water receiving basin overlying the assembly at said top of the housing and provided with a perforated bottom wall; a partition in the basin subdividing the same into a tray for each of said sections respectively; a sump at the bottom of the housing; a partition in the sump subdividing the same into an inner catch basin beneath said portion and said inner section and an outer catch basin beneath the outer section; a hot water feed pipe discharging into the tray overlying the inner section; means for pumping water from the inner catch basin and discharging the same into the other tray; conduit means for draining water from the outer catch basin; and a fan within the tube for directing currents of air through the fill assembly, transversely across the water gravitating therethrough, and thence to said portion of the housing to the stack for discharge therefrom.

2. Structure for the air cooling of water comprising a plurality of hollow housings terminating at one end thereof in a common vertical stack discharging above the top of the housings; an air inlet tube at the opposite end of each housing respectively; a fill assembly in each housing between the tube thereof and each stack and each including an inner section and an outer section; a hot water receiving basin overlying each assembly respectively at the top of the corresponding housings and each provided with a perforated bottom wall; a partition in each basin subdividing the same into a tray for each corresponding section respectively; a sump beneath the housings and the stack; a partition in the sump and surrounding the stack subdividing the sump into an inner catch basin beneath the stack and said inner sections and an outer catch basin beneath the outer sections; a hot water receiving trough surrounding the stack above said tops of the housings, the tray of each inner section having a water feed pipe discharging thereinto coupled with the trough; a manifold surrounding the stack and provided with an outlet for the tray of each outer section respectively; means for pumping water from the inner catch basin and discharging the same into the manifold; conduit means for draining water from the outer catch basin; and a fan in each tube respectively for directing currents of air through the fill assemblies, transversely across the water gravitating therethrough, and thence to said stack for discharge therefrom, said housing surrounding the stack, said feed pipes and said outlets each being provided with

a valve for selectively controlling the flow of water to the trays.

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