March 3, 1970 D. B. FURLONG 3,498,590

SPIRAL DRAFT WATER COOLING TOWER

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FIG. 1.

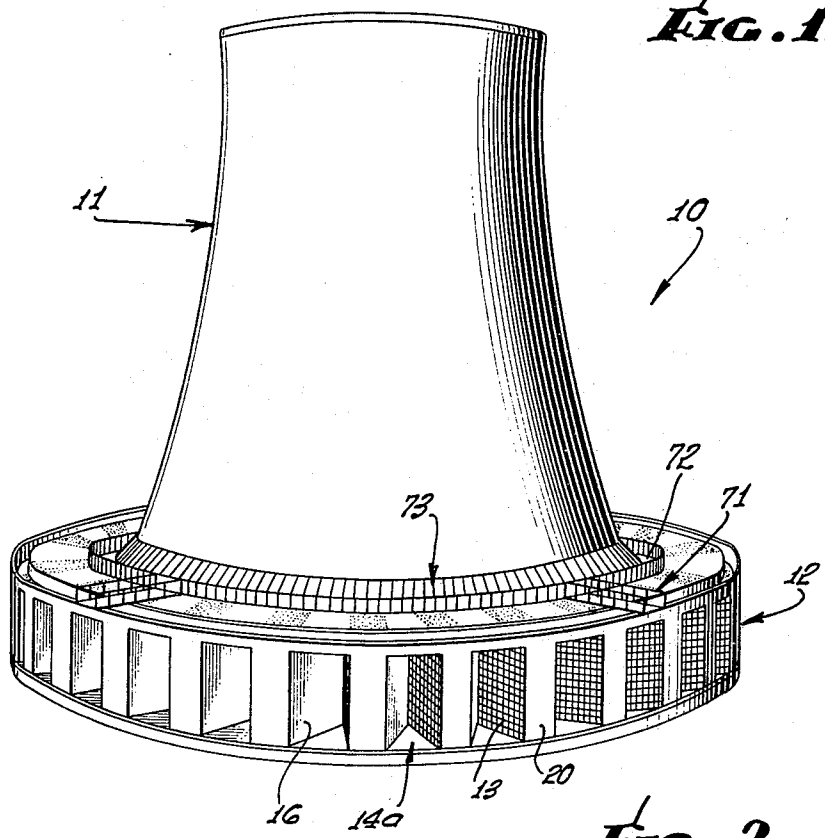


FIG. 2.

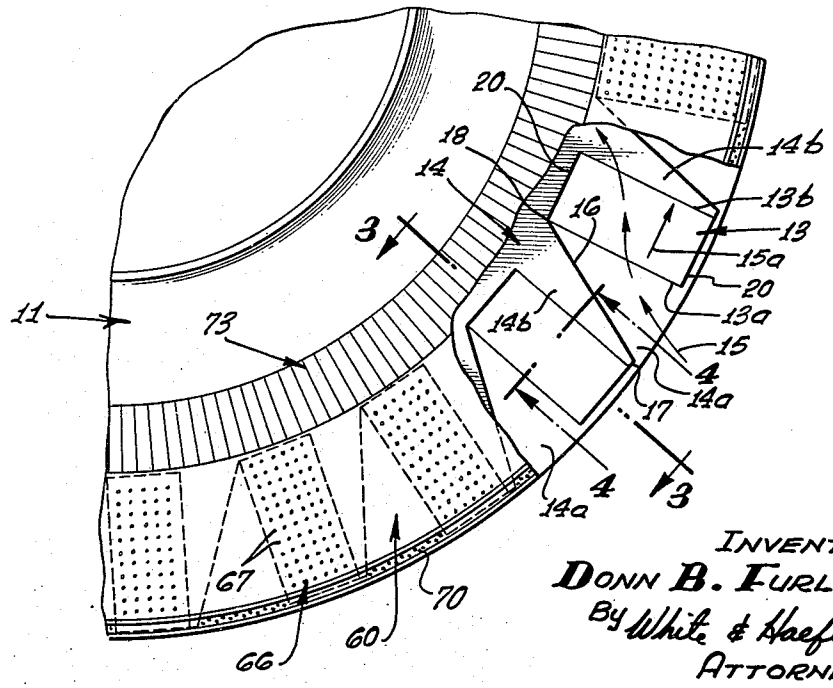


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FIG. 3.

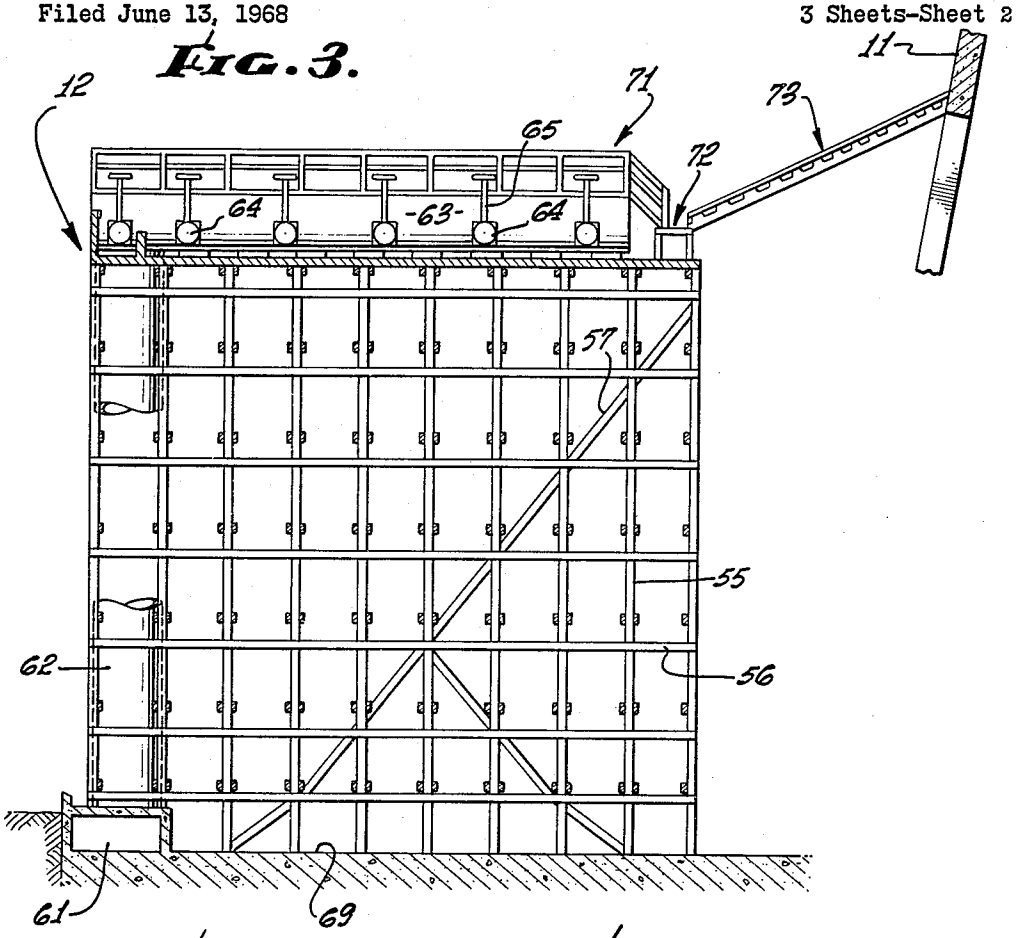


FIG. 5.

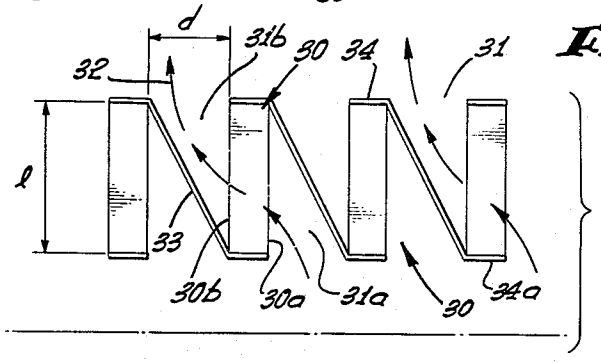


FIG. 6.

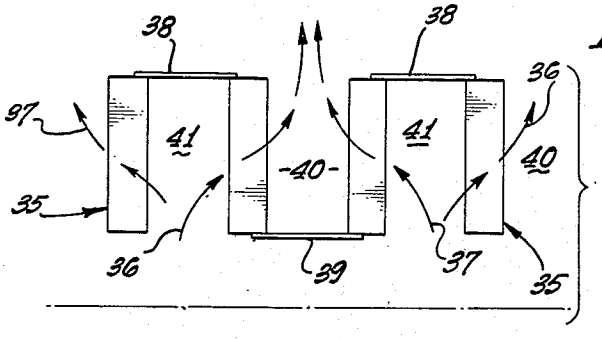


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FIG. 4.

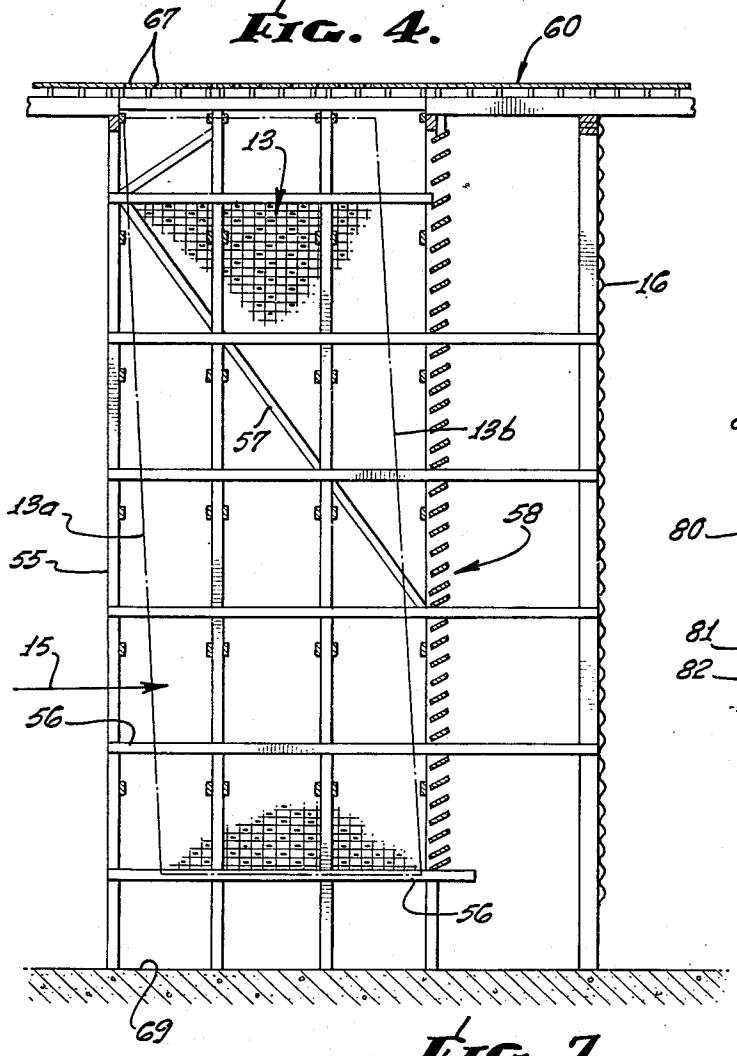



FIG. 8.

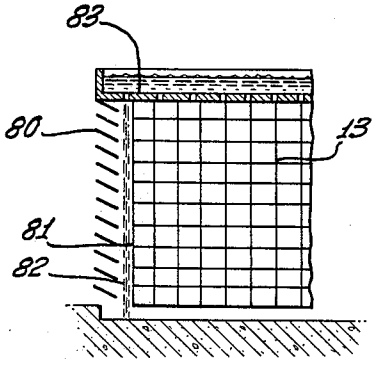
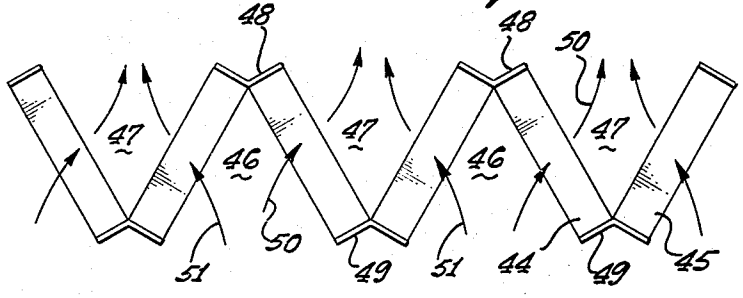



FIG. 7.

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United States Patent Office 3,498,590 Patented Mar. 3, 1970



3,498,590

# SPIRAL DRAFT WATER COOLING TOWER

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Int. Cl. F28c 1/00
U.S. Cl. 261—111 7 Claims

## ABSTRACT OF THE DISCLOSURE

A cooling tower employs packing sections having inlet and outlet sides laterally separated in a direction generally lengthwise of the tower horizontal periphery, for greater efficiency. Other features include a water supply basin along which water flows over the sections and drains thereto, but not to the spaces between the sections; and water may also drain in curtains at the entrances to the spaces between the packing sections, for described purposes.

## BACKGROUND OF THE INVENTION

This invention relates generally to water cooling towers, and more specifically concerns an unusually advantageous and economical tower construction with substantially increased water cooling capacity.

Conventional mechanical draft and natural draft towers typically employ grid decking or packing for draining and splashing water in such dispersed condition as to be cooled by air streams passing generally horizontally through the packing. The packing decks normally extend continuously along the side or sides of such a tower in order to achieve direct inward flow through the packing of all air passing between the exterior and interior of the tower, this having been thought to be consistant with most economical tower construction and mode of operation. For example, it was thought that continuity of packing extent along the tower sides achieves maximum "surface" to "area" ratio, the surface referring to available wetted packing area presented to the entering air, and "area" referring to the ground area covered by the tower.

It has been found, however, that the construction and operation of conventional towers present certain problems and lack of desired economies. For example, louvers are required to guide air flow into the packing and to intercept water splashing outwardly from the grid decking. In cold weather, the water splashing in this manner tends to freeze on the louvers with resultant build-up of ice that can reduce air flow into the tower and damage the tower structure. Added equipment to overcome such icing may include extra conduit and valving to drain warm water onto the louvers, all of which adds to the expense of tower construction and operation.

## BRIEF SUMMARY OF THE INVENTION

It is a major object to provide a tower construction such as will overcome the above referred to problems, as well as others, while at the same time providing unusual advantages contributing to reduction in space occupied by a tower of given capacity, elimination of need for louvers, and a gain in tower operating economy. Basically, the invention is embodied in a tower construction that includes multiple packing sections having inlet and outlet sides laterally separated in a direction generally lengthwise of the tower horizontal periphery; the sections being spaced in that direction for reception of air (or other gas) therebetween prior and subsequent to air flow through the sections between said sides so that



the flow through the sections has substantial components parallel to said direction; and means to supply water (or other liquid) for drainage within the sections to be cooled by the air flow therethrough. As will appear, the invention may be incorporated in either natural draft or mechanical draft towers.

Typically, the tower construction may include certain partitions extending within the spaces between the packing sections to confine the air to enter the sections at the inlet sides and to flow laterally within the sections, such partitions for example extending diagonally between the outer extents of the outlet sides of the sections and the inner extents of the inlet sides of the sections. Further, the tower construction may include other partitions covering the outermost and innermost extents of the sections.

Additional objects and advantages of the invention include the provision of such decking sections circularly arranged about a vertical central axis with section elongation generally radially; the provision of decking sections in a row with parallel elongation normal to the straight direction of tower side extent; the provision of decking sections arranged in a row with dimensional elongation in staggered relation; the provision of water supply means including a water basin overlying the sections and spaces there between, the basin having drainage openings located only over the sections; the provision of means including piping having water outlets directed to discharge water into the basin to flow there along and over the sections and spaces there between; the provision of means to supply warm water to fall in curtains at the entrances to those spaces which receive air between the sections, for flow through the sections, in order to warm that air in cold weather to prevent icing, no louvers being required; and the provision of a basin underlying such spaces to receive water splashing into the spaces from the decking sections.

These and other objects and advantages of the invention, as well as the details of illustrative embodiments, will be more fully understood from the following specification and drawings, in which:

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective elevational showing of one form of natural draft tower incorporating the invention;

FIG. 2 is a fragmentary plan view of a portion of the FIG. 1 tower, and partly broken away to show interior construction;

FIG. 3 is an enlarged elevation taken in section on lines 3—3 of FIG. 2;

FIG. 4 is an enlarged elevation taken in section on lines 4—4 of FIG. 2;

FIG. 5 is schematic plan view of another arrangement of decking sections and partitions;

FIG. 6 is a schematic plan view of a further arrangement of decking sections and partitions;

FIG. 7 is a schematic plan view of yet another arrangement of decking sections; and

FIG. 8 is a section showing a modified tower construction having louvers at the inlet ends of the spaces between the packing sections.

## DETAILED DESCRIPTION OF THE INVENTION

Referring first to FIGS. 1–4, the illustrated water cooling tower **10** is of natural draft type, wherein air is drawn horizontally into the lower interior of the tower and rises in the stack **11** of hyperbolic outline in vertical axial planes. The stack is circular in horizontal planes as is the lower portion **12** of the tower. While the invention is not limited to such natural draft towers, it has unusual advantage when incorporated therein.

Included in the tower is a plurality of water receiving packing sections having inlet and outlet sides laterally separated in a direction generally lengthwise of the tower

horizontal periphery. As seen in FIG. 2, the sections **13** are rectangular in plan view with inlet and outlet sides **13***a* and **13***b* separated in the circumferential direction. Further, the sections **13** are circularly arranged about the vertical central axis of the tower with spacing there between indicated at **14** for reception of air between the sections. Air entering the tower spaces **14***a* then turns to flow through the sections **13** between sides **13***a* and **13***b*, and is then received in spaces **14***b* for subsequent passage to the tower interior. Arrow **15** designates the general flow path. As is clear from FIG. 2, the flow through the sections **13** has a substantial component **15***a* parallel to the (circumferential) direction of the lower horizontal periphery.

Another aspect of the invention has to do with the provision of certain partitions extending within the spaces **14** to confine the air to enter the sections **13** at their inlet sides to flow laterally therein as described. For example, vertical partitions **16** may be provided to extend diagonally between the outer extents **17** of the outlet sides **13***b* of the sections **13** and the inner extents **18** of the inlet sides **13***a* of the sections. Further, other vertical partitions **20** and **20** are provided to cover the outermost and innermost extents of the sections **13**, whereby the tower appears in FIG. 1 as inwardly recessed at **14***a*.

Typically, the like sections **13** are radially horizontally elongated and the overall radial dimension of the section multiplied by the number of such sections substantially exceeds the boundary dimension (as for example circumference) defined by the outer extents of the sections. Accordingly, a substantially higher than normal ratio of "surface" to "area" is achieved, these terms having been previously defined.

Referring now to FIG. 5, packing sections **30** are shown spaced apart linearly at **31**, as in the case of a rectangular tower construction. Air enters the spaces **31***a*, flows through the sections via their inlet and outlet sides **30***a* and **30***b*, and enters the tower interior via the spaces **31***b*, arrow **32** indicating such flow. Diagonal partitions **33**, and partitions **34** and **34***a* at the inner and outer ends of the sections, serve the same functions as the previously described partitions.

FIG. 6 illustrates an arrangement of inwardly elongated packing sections **35** similar to that of FIG. 5; however, the air flow is caused to follow the paths indicated by arrows **36** and **37**. This divided flow pattern is effected by provision of partitions **38** and **39** extending between pairs of the sections **35** at their inner and outer sides respectively, in such manner that certain alternate spaces **40** between the sections **35** are outwardly covered and inwardly exposed to the tower interior, and other alternate spaces **41** between the sections are inwardly covered and outwardly exposed to the tower exterior. In both FIGS. 5 and 6, the long dimensions *l* of the sections are greater than the dimension *d* of the spaces between the sections, whereby the 'surface" to "area" ratio referred to above is substantially enhanced.

In FIG. 7, the decking sections **44** and **45** are arranged in a row and are dimensionally elongated in staggered relation, i.e. the sections extend lengthwise in zig-zag fashion. This arrangement results in the creation of certain alternate spaces **46** which are outwardly exposed and inwardly closed and other alternate spaces **47** between the sections which are exposed toward the interior of the tower, but outwardly closed. Partitions **48** and **49** at the ends of the sections prevents air flow through those ends, and aid divided air flow in the directions as indicated by arrows **50** and **51**. Here again the total length of the sections through which the air flows is much greater than the peripheral length of the tower along its outer side or sides.

Referring back to FIGS. 1–4, means is provided to supply liquid, as for example water, for drainage within the sections in order to be cooled by air flow through the latter, the water typically falling in dispersed drops which splash and film on the decking surfaces or slats. Many different types of decking or fill may be used, FIG. 4 indicating a closely packed section **13** of such fill as inclined downwardly and in the direction **15** of air flow through the fill, water particles tending to fall in the packing with corresponding angularity from vertical. Tower structure supporting the fill includes uprights **55**, cross pieces **56** and bracing **57**. An upright drift eliminator **58** is spaced close to the outlet side **13***b* of the packing for eliminating drift particles from the air stream.

The water supply means illustrated in the drawings includes a water basin **60** overlying the packing sections **13** and the spaces **14***a* and **14***b* there between. As seen in FIG. 3, hot water may be pumped from a concrete supply conduit **61** upwardly within a riser **62** to a flume or piping **63** extending transversely and inwardly across the basin **60**. The latter has multiple outlets **64**, individually valve controlled at **65**, directed to discharge water into the basin for open channel flow there along in the length direction of the basin. The basin has intermittent groups **66** of drainage openings **67** located lengthwise thereof, for draining water into and onto the decking or packing sections **13**; also the basin over the spaces **14** between sections **13** is free of such holes so that water does not drain from the basin into the interiors of those air spaces. On the other hand, any water splashing from the packing into the spaces **14** falls into the collection basin **69** at the bottom of the tower, and no louvers are needed to intercept such splash since spaces **14** are within the tower.

Further, means is provided to supply warm water to fall in curtains at the entrances to spaces **14***a*, in heat transfer relation with air received into the spaces **14***a*, whereby in cold weather the air is pre-heated before it reaches the packing sections to prevent icing. In the illustrated embodiment of FIGS. 1–4, the basin **60** extends outwardly over the air entrances to spaces **14***a*, and localized groups **70** of drainage outlets are provided in the basin to drain water in curtains at those entrances.

To complete the description, access walkways are shown at **71** over the piping **63**; walkway **72** extends along and at the inner side of the basin **60**; and openable and closable auxiliary air inlet structure **73** extends between the basin and the stack **11** for allowing auxiliary cool air to enter the tower and thereby reduce the natural draft induced flow of air through the packing sections **13** in extremely cold weather, helping to prevent icing of those sections.

Finally, FIG. 8 illustrates an alternate arrangement wherein the packing sections and partitions are the same as in FIG. 2, excepting that outermost partition **20** is not used. Instead, a series of vertically spaced, downwardly and inwardly inclined louvers **80** is substituted to provide more flexible air flow with less pressure drop under certain conditions. Louvers **80** extend near the outer extremities **81** of the sections **13**, to direct air to flow into the sections, while intercepting any outward splash. A curtain **82** of warm water falls from the basin **83** and between the louvers and the section **13**, suitable water passing openings being provided in the basin. Curtain **82** warms the entering air and the louvers to prevent icing in winter.

I claim:

**1.** In a cooling tower having a generally circular horizontal cross section and a vertical axis, the combination comprising a plurality of upright generally annularly spaced packing sections having open inlet and outlet sides laterally separated in a direction generally lengthwise of the tower horizontal periphery,

the sections being spaced in said direction and about said axis for reception of gas therebetween prior and subsequent to gas flow through the sections between said sides so that the flow through the sections has substantial components parallel to said direction, said

sections also being radially outwardly spaced from said axis,

certain upright partitions located in said spaces between the sections and extending generally diagonally between the outer extents of said outlet sides of the sections and the inner extents of said inlet sides of the sections, thereby to direct the gas to flow in a spiral course about said vertical axis as the gas passes through said sections and into the tower interior inwardly of said sections, said certain partitions extending vertically throughout approximately the heights of said sections, there being other partitions located at the radially inner and outer ends of the sections to block air flow through the outermost and innermost extents of said sections, said sections being radially inwardly elongated,

and means to supply liquid for drainage within said sections to be cooled by the gas flow therethrough, said gas flow in a spiral course inducing enhanced mixing of the moisture laden gas so as to decrease the density thereof thereby to increase the tendency of the gas to rise in the tower.

**2.** The combination of claim **1** in which said supply means includes a water basin overlying said sections and spaces and having intermittent groups of drainage openings located there along.

**3.** The combination of claim **2** wherein said supply means includes piping having water outlets directed to discharge water into the basin to flow there along in said direction.



**4.** The combination of claim **1** including means to supply warm water to fall in curtains at the entrances to said spaces which receive air for flow laterally through the sections.

**5.** The combination of claim **1** including a water receiving basin underlying said spaces to receive water splashing into said spaces from said packing sections.

**6.** The combination of claim **1** including air inlet louvers at the outer extremities of said spaces, the louvers inclined downwardly and toward said outer extremities.

**7.** The combination of claim **6** wherein said liquid supply means includes basin openings to pass water to drain in curtains between said outer extremities and said louvers.


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U.S. Cl. X.R.

55—233, 240, 257, 483, 484