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Fordyce et al.

[11] **3,880,964**

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[54] **HOT WATER SUPPLY AND DISTRIBUTION STRUCTURE FOR COOLING TOWERS**

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[52] **U.S. Cl.** **261/111**; 261/DIG. 11

[51] **Int. Cl.** **B01f 3/04**

[58] **Field of Search** 261/DIG. 11, 110, 111, 261/66, 67, 71, 113, 91

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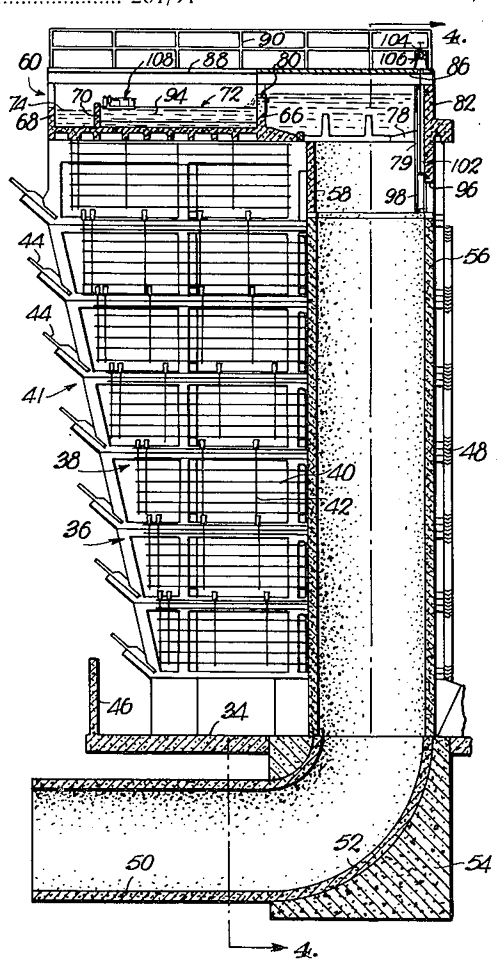
[57] **ABSTRACT**

A crossflow cooling tower having fireproof liquid supply means including a riser opening directly into an overhead flume located inwardly of and adjacent to a hot water distributor for supplying hot liquid to be cooled to the latter. A liquid stilling chamber is provided between the riser and flume to prevent nonuniform, turbulent liquid delivery to the distributor. A horizontal conduit which is normally submerged in the hot liquid delivers liquid from the inlet flume to an outer section of the distributor to permit variation of the water delivery pattern to the fill assembly for temperature control purposes to deice the fill assembly during below freezing operation. Valve means actuated by a pneumatically expansible baffle variably restricts flow through the conduit, and the resilient nature of the baffle facilitates breakup of any ice which may tend to form thereon. A shiftable gate-controlled opening in the stilling chamber allows the operator to bypass the hot liquid around the fill assembly without cavitating the liquid power supply means.

6 Claims, 10 Drawing Figures



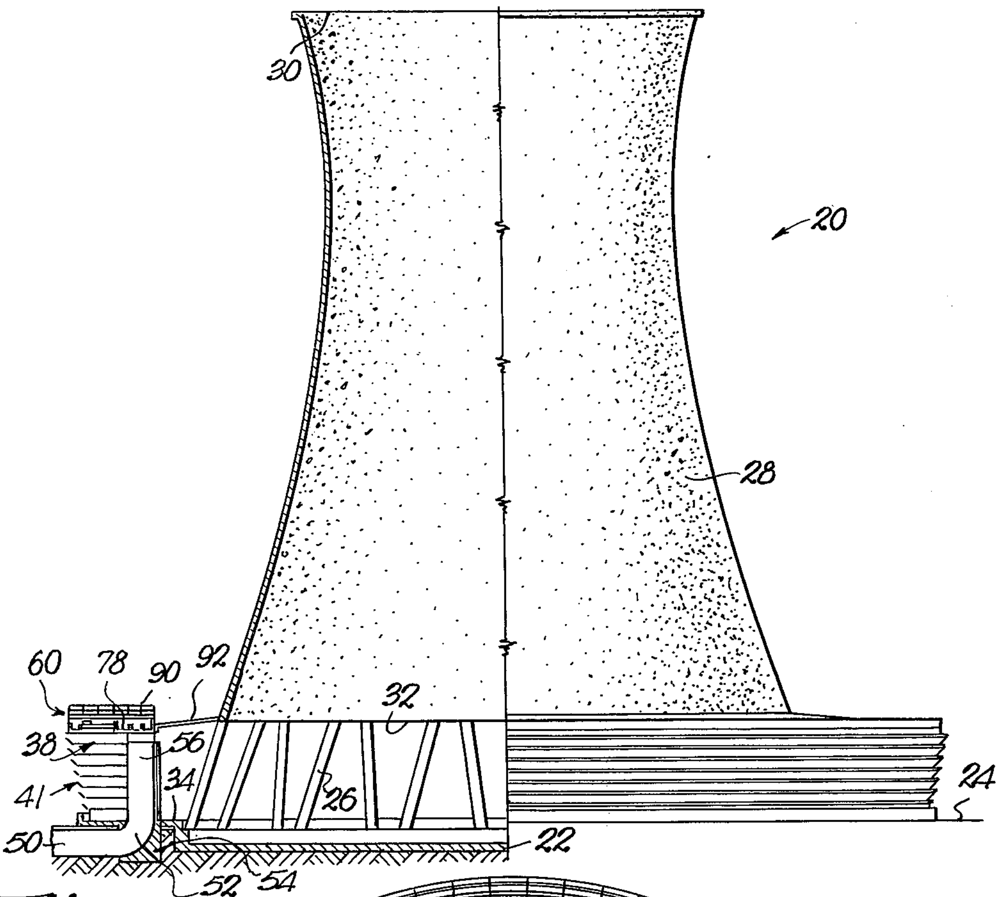

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Fig. 1.

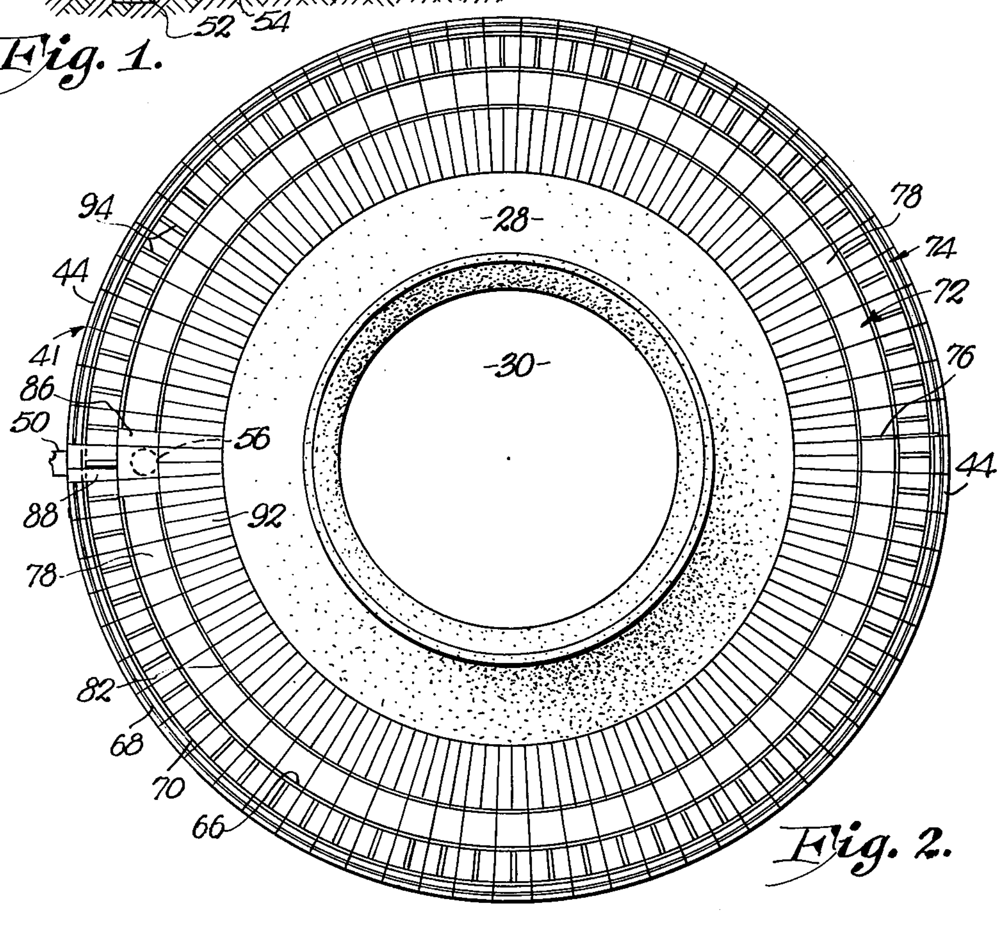
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Fig. 2.

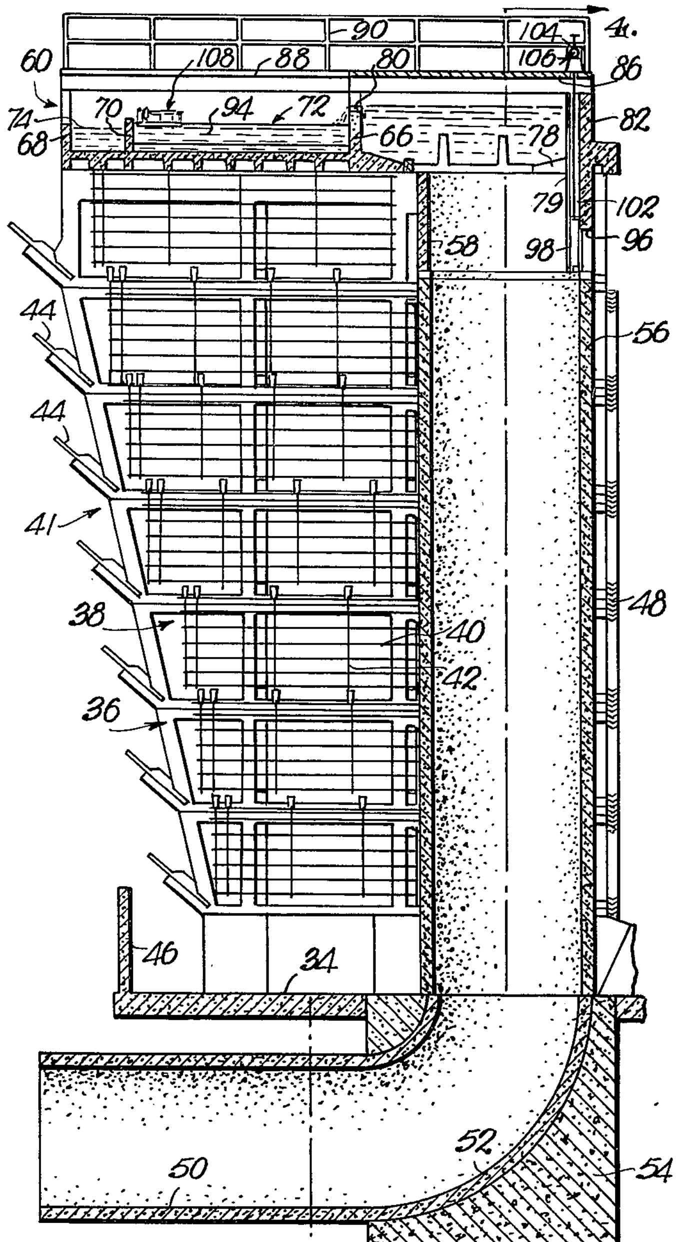

Fig. 3.

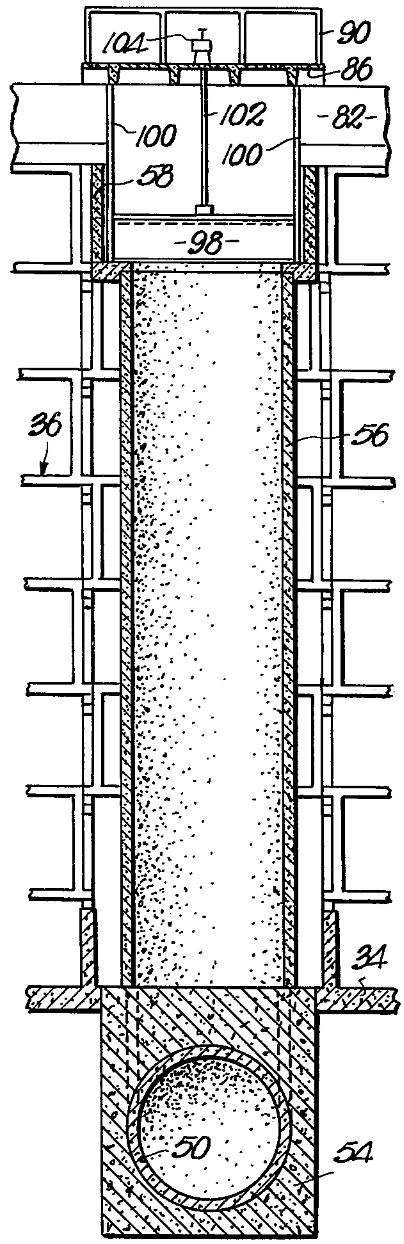

Fig. 4.

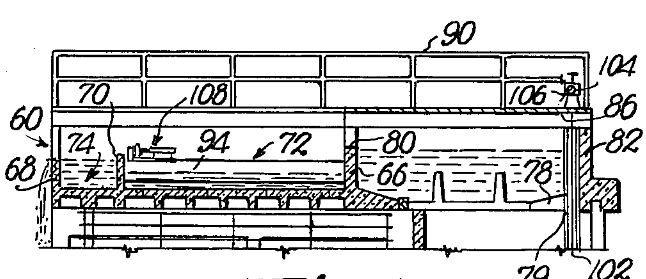

Fig. 5.

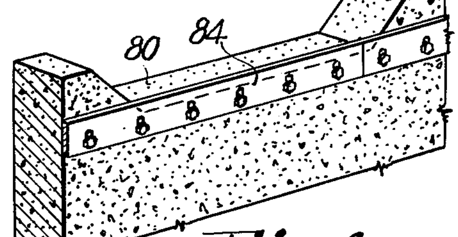

Fig. 6.

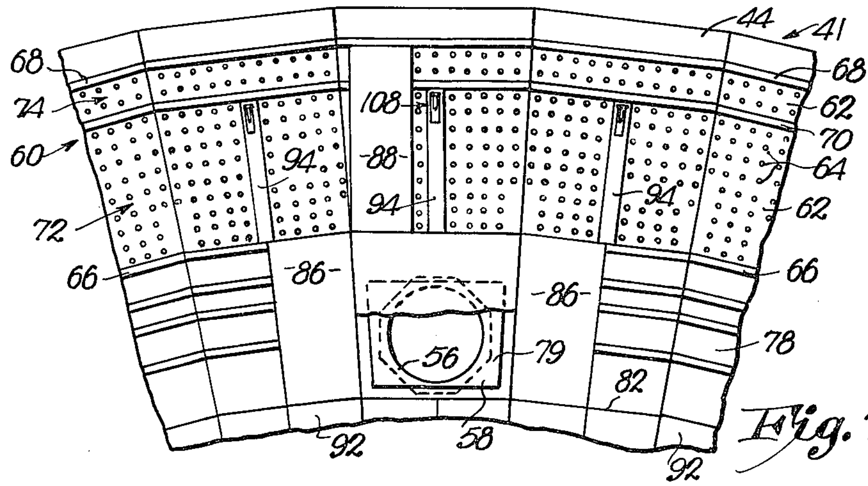

Fig. 7.

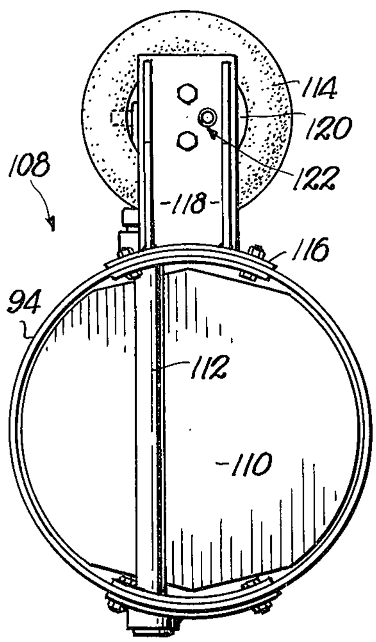

Fig. 8.

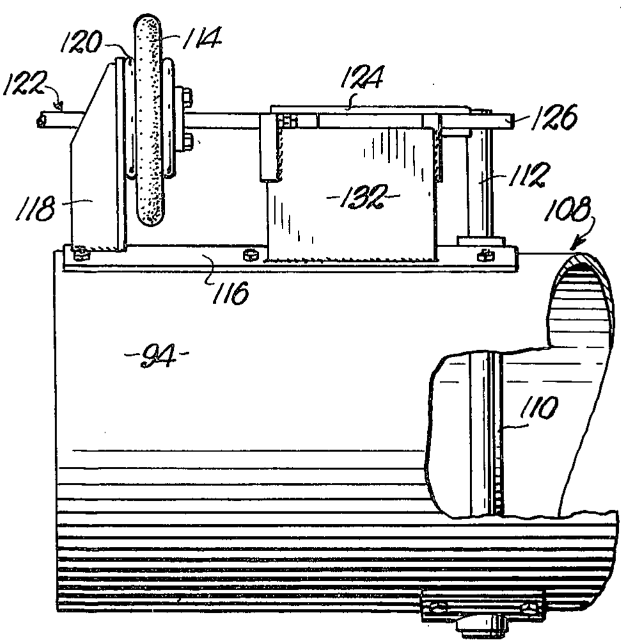

Fig. 9.

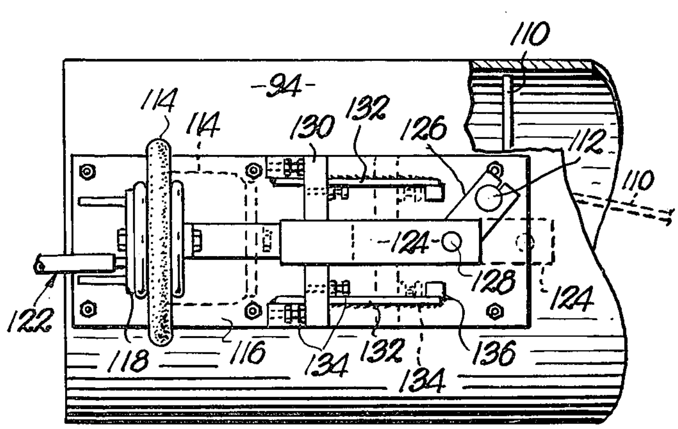

Fig. 10.

HOT WATER SUPPLY AND DISTRIBUTION STRUCTURE FOR COOLING TOWERS

This invention relates to liquid cooling towers and relates more specifically to improved hot liquid supply means therefor.

Liquid cooling towers generally include a hot liquid distributor in the form of a distribution basin that overlies a fill assembly through which the liquid graviates in intimate, evaporative heat exchange relationship with a cooling airflow passing through the fill assembly. The cooled liquid is collected in an underlying basin and returned to be utilized in, for instance, a power plant from where the liquid is pumped back to be recycled through the cooling tower. Cooling towers of the class described may employ natural draft techniques for creating a crossflow movement of cooling air through the fill assembly such as by utilization of a hyperbolic stack wherein the fill assembly is placed circumferentially around the lower portion of the stack. Also an induced draft of cooling air may be created by incorporating fans for drawing airflow through the fill assembly.

Heretofore, cooling towers have necessarily required substantial lengths of large diameter piping for supplying the liquid to the distribution basin in flow patterns assuring liquid delivery to all portions of the basin for efficient cooling tower operation. Particularly in larger sized cooling towers such as those capable of handling flow rates upwards of hundreds of thousands of gallons per minute or more, such supply piping is extremely expensive in initial construction and is difficult and expensive to assemble in place in the tower in the normal liquid delivery disposition thereof. Most efficient cooling operation occurs when liquid is delivered uniformly to the overhead distribution basin throughout the entire length thereof, thereby necessarily requiring equivalent lengths of horizontal feeder piping extending generally parallel to the distributor. Furthermore, conventional piping has also been utilized for riser structure carrying liquid to the elevated, horizontal feeder pipes. In many instances where high volume flow rates are encountered, a plurality of risers must be incorporated to deliver liquid to separate sections of the horizontal feeder piping.

Preferably, the supply piping is formed of noncombustible, noncorrosive material. While it has been known to construct such piping of suitable wood material such as redwood, it has been found that wooden components are undesirable, particularly where very large cooling towers are involved, because the use of wood presents a fire hazard as well as expensive construction and continual maintenance problems. Furthermore, the relatively massive nature of such piping presents serious problems of installation.

It has been conventional practice, especially in crossflow type cooling towers, to locate the riser exteriorly of the fill assembly, thereby requiring more piping to deliver liquid horizontally into the feeder piping. Attempts to utilize open-top inlet flumes in place of the feeder piping have heretofore been unacceptable in practice as the large flow volumes have created excessive boiling of the liquid in the flume and consequent nonuniform liquid delivery into the distribution basin. The need is apparent, therefore, to provide an alternate, economically acceptable, fireproff arrangement for supplying liquid to the overhead distribution basin which utilizes a minimum amount of liquid supply piping.

It is desirable in many instances that the water loading on different portions of the fill assembly be selectively varied in relation to different ambient temperatures and other climatic factors to assure optimum tower performance. For instance, it is desirable to increase the water loading at the outer section of the fill assembly adjacent the air inlet thereto during below freezing operation to preclude icing of the air inlet louvers which would otherwise greatly restrict airflow through the fill assembly. One successful answer to this problem is taught in U.S. Pat. No. 3,322,409, owned by the assignee hereof, wherein the overhead distribution basin includes a pair of separate sections overlying inner and outer portions of the fill assembly. Piping delivers liquid along separate paths to these two sections of the distribution basin, and control valve means interposed in the supply pipes allow selective variation of flow to respective sections of the basin. However, this arrangement still necessarily includes a considerable amount of expensive supply piping. The piping which carries liquid to the outer section of the distribution basin usually carries a less than full water load except on occasions when substantially the entire liquid flow is diverted therethrough to the outer section to deice the air inlet louvers of the fill assembly. Also, such piping can freeze-up during low water loading under extremely low temperature. An associated problem is the tendency of the actuating mechanism of the valve which controls flow to the outer section of the distribution basin, to collect ice and freeze solid. Necessarily this actuating mechanism is disposed above the distribution basin in a location exposed to an atmosphere of cold, fine water spray tending to ice the mechanism. When frozen solid of course, malfunction occurs with consequent loss of control of the liquid flow to the outer distribution basin which may ultimately require shutdown of at least certain portions of the cooling tower during cold weather for deicing.

In many instances of operation of a power plant utilizing the liquid being cooled by such a cooling tower, it is desirable to cool the liquid only to a certain level before return thereof to the power plant. For example, when starting up large turbines of a power plant wherein the turbines must be brought to a certain temperature before efficient operation occurs, it is necessary to continually recirculate hot liquid through the turbines. Underground piping carries liquid back and forth from the tower to the plant, and it has been conventional practice to include additional bypass piping, also usually located underground, extending between the supply piping and return piping. Remotely operated control valves selectively control flow of hot water through this bypass piping so that the liquid may be returned to the plant in its fully heated condition without passing through the cooling tower. A problem associated with such bypass arrangement is the tendency to form cavitation conditions at the inlet liquid circulating pump when the cooling tower is being bypassed. Loss of back pressure usually occurs when the liquid is bypassing the cooling tower, causing liquid starvation and erosion of the pump by cavitation. Furthermore, the additional bypass piping and remotely operated control valves add to the cost of the cooling tower installation.

It is, therefore, the primary object of the present invention to provide a cooling tower which utilizes a minimum amount of expensive piping for supplying liquid thereto, while at the same time allowing variable hot liquid delivery to the tower in flow patterns assuring most efficient cooling operation thereof.

An important object of the invention is to provide a cooling tower wherein the utilization of expensive, overhead, horizontal feeder piping for delivering liquid to the distribution basin is substantially avoided without sacrifice of uniform supply of the liquid to the basin along substantially the entire length thereof for efficient tower operation.

A corollary aim of the invention is to provide an open top inlet flume in place of conventional feeder piping, wherein the flume is comprised of a plurality of prefabricated components that may be precast at ground level in any desired configuration and which are of a size permitting handling thereof by conventional construction lifting equipment, thereby providing an inlet flume which may be efficiently and economically assembled at far less expence in construction than heretofore using other forms of liquid supply apparatus.

Another object of the invention is to provide a prefabricated liquid supply riser of inexpensive design and construction which delivers liquid to the flume, wherein both the riser and the flume components are precast out of noncombustible material so that the entire liquid supply means of the cooling tower is fire-resistant.

Another important object is to provide a supply riser that is located directly underneath the flume for delivering liquid generally vertically thereinto to eliminate overhead horizontal supply piping, as well as to permit the riser to be configured as desired since it simply opens into the bottom of the trough-like flume instead of being connected in sealed relationship with circular feeder pipes, thereby allowing use of larger risers which are less expensive, yet capable of handling greater flow rates than conventional pipe-type risers and attendantly reducing the number of risers required.

Another object is to provide such an arrangement wherein the inlet flume and supply riser are sufficiently massive to remain in place on the tower without being rigidly attached or fastened thereto.

A further object is to provide a cooling tower wherein liquid is delivered from the riser vertically into an inlet port in the flume without causing boiling of liquid in the flume which would otherwise create excess liquid flow into portions of the distributor proximal to the inlet port, thus assuring substantially uniform liquid flow into all portions of the distributor. A more particular object is to provide simple, inexpensive means for preventing such boiling of the liquid in the form of a liquid-stilling chamber located between the riser and the flume which substantially reduces the vertical velocity of the liquid prior to its introduction into the flume.

A further object is to provide a cover overlying portions of the flume proximal to the inlet port for assisting in reducing the vertical velocity of the liquid at conditions of maximum or near maximum inlet flow rates, so that the stilling chamber may be of smaller dimensions effective to adequately reduce the liquid vertical velocity at normal flow rates, without creating excessive boiling at maximum flow rate conditions.

Another important object of the invention is to provide a cooling tower which utilizes an inlet flume and supply riser as characterized in the foregoing objects which are arranged to supply liquid in various proportions to separate inner and outer sections of the distribution basin to permit optimum, efficient operation of the cooling tower under markedly varied climatic enviroments and under different operational conditions.

Another very important object of the invention is to provide a cooling tower having supply means for directing liquid in various proportions along separate paths to two independent sections of a distribution basin overlying inner and outer portions of the fill assembly respectively so that liquid loading on the outer portion of the fill assembly may be selectively varied to permit operation of the tower at optimum efficiency throughout a variety of climatic and operational conditions. Hot liquid flows from the supply means to the outer section of the basin through a conduit which is submerged in liquid collected in the inner section of the basin.

Another important object of the invention is to provide a liquid cooling tower wherein liquid flow may bypass the fill assembly without cavitating the pump which is delivering liquid to the cooling tower.

Another object of the invention is to provide a cooling tower wherein liquid may be bypassed around the fill assembly without the use of heretofore required expensive underground bypass piping and remotely operated valve means configured to control flow through the bypass piping.

A more particular object is to provide a riser for supplying liquid to a distribution basin overlying the fill assembly, wherein the riser has an opening through which liquid may gravitate directly back to the underlying collecting basin in bypassing relationship to the fill assembly without flowing through additional bypass piping.

Another object is to provide such a bypass opening which is disposed at a height to maintain positive back pressure in the riser to prevent liquid starvation and consequent formation of cavitation conditions at the supply pump while the fill assembly is being wholly or partially bypassed.

Yet another object is to provide a riser, flume and stilling chamber arrangement as set forth above wherein the bypass opening is located in the stilling chamber to assure complete liquid bypass of the distribution basin and fill assembly even at high inlet flow rate conditions.

Another particular object of the invention is to provide economical, dependable valving for controlling flow through the bypass opening in the form of a gate that is vertically shiftable to variably close the opening so that the drive means for operating the gate may be disposed at an easily accessible location above the distribution basin.

Another important object of the invention is to provide improved valve means for controlling flow through a conduit supplying liquid to a cooling tower, wherein the valve means has a reliable actuating mechanism that is not subject to malfunction by freezing even though exposed to an atmosphere of cold liquid spray tending to ice the mechanism. Another object is to provide an actuating mechanism including a resilient actuator which flexes during operation to readily breakup films of ice thereon each time it is operated to preclude malfunction due to freezing. A more particular object is to provide such an actuating mechanism in the form of a pneumatically expansible bladder of resilient material which expands and contacts to actuate the flow control valve, wherein the resilient nature of the bladder facilitates easy breakup of icing thereon every time the bladder expands and contracts.

These and other objects and advantages of the present invention are specifically set forth or will become apparent from the following detailed description of a preferred embodiment of the invention when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is an elevational view of a natural draft cooling tower embodying the present invention with the left half of the tower being in cross section to reveal internal construction;

FIG. 2 is a top plan view of the tower illustrated in FIG. 1;

FIG. 3 is an elevational, cross-sectional view of the fill assembly portion of the tower and showing the liquid supply means;

FIG. 4 is a cross section as viewed along lines 4—4 of FIG. 3;

FIG. 5 is a partial elevational, cross section similar to FIG. 3 and showing operation of the liquid supply means during deicing of the air inlet louvers of the tower;

FIG. 6 is an enlarged, fragmentary, perspective view of the common sidewall between the inlet flume and the distribution basin;

FIG. 7 is a partial top plan view of the arrangement shown in FIG. 3 with portions broken away to reveal details of construction;

FIG. 8 is a front elevational view of the valve controlling flow to the outer distribution basin;

FIG. 9 is a side elevational view of the valve shown in FIG. 8 with portions broken away for clarity; and

FIG. 10 is a top elevational view of the valve shown in FIG. 8.

Referring now more particularly to FIGS. 1–7, a crossflow type natural draft water cooling tower is broadly designated by the numeral **20** and includes a circular shell foundation **22** located below ground level **24.** A series of inclined support columns **26** carry an upright, hyperbolic reinforced concrete shell **28** in supporting relationship upon the foundation. The shell has an air outlet **30** at its upper end and a lower circular margin **32** is spaced from ground level to define an air inlet around the entire circumference of the shell. The configuration of shell **28** creates a natural draft of airflow horizontally through this air inlet, and defines an exhaust path for exhausting this airflow generally vertically out of air oulet **30.**

An annular, concrete, cold water collection basin **34** surrounds shell **28** and serves to support framework, broadly referred to as **36,** which carries a series of crossflow fill assemblies **38** in overlying relationship to collection basin **34.** The fill assembly may comprise, for instance, a plurality of noncombustible, horizontal splash bars **40** of corrugated configuration carried by vertical, noncombustible support grids **42.** At the outer peripheral margin **41** of the fill assembly which is sloped inwardly because of the tendency of water gravitating through the fill assembly to draw back in the direction of airflow, there is provided a series of relatively wide, horizontal air inlet louvers **44** through which air is drawn generally horizontally through the fill assembly in crossflow relationship to water gravitating vertically downwardly through the latter. The louvers **44** are inclined in the direction of airflow through the fill assembly and are positioned in vertically staggered relationship with the lowermost margin of each louver located above an area of the louver there next below intermediate the longitudinal margins of the latter. A suitable ring of drift eliminators **48** is located at the inner side of the fill assembly **38** to promote removal of carrry-over or drift of liquid in the airflow prior to being discharged vertically out of shell **28.** A curb wall **46** at the outer peripheral margin of collection basin **34** facilitates collection of liquid therein for subsequent exhaust through return piping (not shown).

Overlying fill assembly **38** is a hot liquid distributor generally designated by the numeral **60** that comprises a plurality of precast, radical segments which are of a size facilitating lifting thereof by construction equiqment for emplacement above the fill assembly in an annular ring around the circumference thereof. Each of these distributor components includes a plurality of floor panels **62** having orifices **64** therein adapted to receive metering nozzles which distribute liquid uniformly across the fill assembly. The distributor has an inner wall **66** of greater height than its outer wall **68,** and a third wall **70** of a height than its outer wall **68,** and a third wall **70** of a height intermediate that of the inner and outer walls. Wall **70** divides the distributor into inner and outer liquid collecting and distribution basings **72** and **74** which respectively overlie inner and outer portions of fill assembly **38,** the outer portion being located closer to the outer peripheral margin **41** than the inner portion. The lowermost outer wall **68** is located adjacent outer peripheral margin **41** of the assembly so that liquid overflowing wall **68** will cascade down air inlet louvers **44.** Each of the basins **72** and **74** extend circumferentially around the fill assembly, and a vertical partition **76** is included at a location diametrically opposite riser **56,** as best illustrated in FIG. **2.**

The liquid supply means generally includes a horizontal, buried inlet pipe **50** having a right-angle elbow section **52** at one end thereof which opens upwardly at a location inside the outer peripheral margins of the collection basin **34** and fill assembly **38.** A concrete block **54** cast around elbow **52** absorbs inclined thrust exerted upon the elbow by liquid flowing therethrough. A large diameter, precase concrete riser **56** (shown as being octagonal although it may be of any cross-sectional shape) rests atop elbow **52** and extends vertically upwardly toward the upper proximity of the fill assembly. An open top, liquid collection box **58** is positioned in stacked relationship upon riser **56** to communicate with the upper discharge end thereof. Box **58** is also preferably precast out of concrete material and is of a size having substantially greater transverse, cross-sectional area than the transverse, cross-sectional area of the circular interior of riser **56.**

Disposed directly above collection box **58** is a trough-like, open top inlet flume **78** which has an inlet port **79** in a bottom panel thereof providing liquid communication between the collection box and the flume. Flume **78** is located inboard of distributor **60** in relation to the flow of air therethrough, and is comprised of a plurality of precast concrete components disposed adjacent respective segments of the distributor to extend circumferentially around the fill assembly. The distributor inner wall **66** presents a common sidewall between flume **78** and the distributor **60.** Preferably, wall **66** is provided with a plurality of depressions **80,** at least one for each respective component of the distributor, so that liquid is delivered to the distributor along the entire length thereof simply by collecting in the flume to a level overflowing depressions **80.** Uniform flow into all segments of the distributor is readily accomplished by locating depressions **80** at a uniform height. Inboard flume wall **82** is, of course, higher than depressions **80** to facilitate the collection of liquid in the flume to the overflow level to assure delivery therefrom throughout the length of the flume and distributor. If desired, vertically adjustable panels **84** at each depression **80** may be included so as to vary the effective height thereof.

A cover **86,** as best seen in FIG. **7,** may be included above the portions of flume **78** proximal to collection box **58** and riser **56.** The cover may be coplanar with, and define a portion of a horizontal access walkway **88** that has a side handrail **90.** A canopy **92** in the form of a series of precast concrete panels extends between the lower marginal edge of shell **28** and flume inner wall **82** to close the space therebetween and assure passage of air in crossflow relationship horizontally through the fill assembly into the lower portion of the shell.

Collection box **58** has a relatively wide, rectangular bypass opening **96** in the inboard vertical wall thereof facing away from the fill assembly. A rectangular plate-like gate **98** blocks opening **96** in its closed position illustrated to prevent bypass flow through opening **96.** Gate **98** has rollers at its opposite marginal edges which are shiftably received within vertical channels **100** secured to the inside of collection box **58,** channels **100** acting as guides for gate **98** as it shifts vertically to allow flow through opening **96.** A vertical screw shaft **102** is rotatably secured to gate **98** and extends upwardly therefrom to above walkway **88** wherein drive means **104** is secured to the upper end of the screw shaft **102.** In the form illustrated, gate **98** is manually operated by rotation of a control handle **106** to actuate the drive means in raising and lowering the screw shaft and gate.

A series of conduits **94** extend across respective segments of the inner distribution basin **72** and through walls **66** and **70** to deliver hot liquid from flume **78** to the outer distribution basin **74.** The conduits **94** are disposed at an elevation below depressions **80** and submerged within liquid collected in the inner distribution basin **72.**

Valve means generally designated by the numeral **108** variably restricts the flow through conduit **94** to outer basin **74.** As best seen in FIGS. **8-10,** the valve means includes a plate **110** substantially traversing the interior of conduit **94** in a position allowing minimum flow therethrough. Plate **110** is secured for rotation with a transversely extending shaft **112** that is rotatably carried upon conduit **94** offset to one side of the center thereof. An actuator in the form of a pneumatically expansible, annular bladder **114** formed of resilient material is mounted atop conduit **94** by a support which includes horizontally and vertically arranged plates **116** and **118.** Bladder **114** is secured through a metal ring **120** to vertical plate **118** with a pressurized inlet port and conduit **122** in plate **118** communicating with the interior of bladder **114.** The opposite side of bladder **114** is connected to linkage in the form of a longitudinal bar **124** and pivotal link **126** to an upper end of shaft **112** lying outside conduit **94.** Link **126** is rigidly attached to shaft **112** and pivotally secured to bar **124** at point **128** so that longitudinal expansion and contracting of bladder **114** effects rotation of shaft **112** and plate **110** between the minimum flow position illustrated, and a position affording maximum flow through the conduit **94** wherein plate **110** extends generally parallel to the longitudinal axis of the conduit as shown by phantom lines in FIG. **10.** A crossbar **130** secured to bar **124** is guided upon a pair of spaced, vertical plates **132.** Adjustable stop nuts **134** carried by the vertical plates **132** and crossbar **130** are respectively engageable with the crossbar and stop lugs **136** on the vertical plates for limiting the linear, longitudinal stroke of bladder **114.** Nuts **134** are adjustable to vary the length of stroke of the bladder.

In operation, hot liquid is forced by high volume pumping means through the underground inlet pipe **50** and elbow **52** to flow vertically upwardly in riser **56** into collection box **58.** The larger transverse, cross-sectional area of box **58** in relation to the riser causes liquid to disperse in the box prior to flow into the flume so that the collection box **58** acts as a stilling chamber, causing substantial reduction in the vertical velocity of liquid delivered from riser **56.** The height of box **58** assures that the vertical velocity of the liquid is reduced to an extent such that the liquid, upon consequently flowing into flume **78,** spreads horizontally throughout inlet flume **78** without creating a "boil" of liquid in the flume at inlet **79** of greater height than the normal level of liquid collected in the flume. Without inclusion of collection box **58** to reduce the vertical velocity of the liquid, such liquid would boil upwardly to a higher than normal level in the portion of the flume proximal to its inlet port **79,** to create an attendent excess flow into the adjacent portions of the distributor at the expense of reduced flow into the remote portions of the distributor. This nonuniform flow would accordingly reduce the efficiency of the tower in cooling the liquid.

The hot liquid distributes and collects along the entire length of flume **78** to the level overflowing the several depressions **80** in wall **66** to distribute uniformly throughout the entire peripheral length of inner distribution basin **72.** As necessary, the panels **84** may be variably adjusted in height to assure uniform liquid distribution into basin **72.** The hot liquid flows through orifices **64** in the floor panels of the inner basin **72** to be distributed uniformly for gravitation through the underlying fill assembly **38.** Normally, valve means **108** is in its minimal flow position allowing a certain preselected volume of flow into outer basin **74.** Liquid subsequently gravitates uniformly through all portions of the fill assembly in intimate, evaporative heat exchange relationship with the path of cooler air passing in horizontal crossflow relationship to the liquid flow. The cooled liquid is collected in underlying basin **34** and returned to be recycled through the power plant being serviced by the cooling tower.

Accordingly, the supply means of the present invention delivers hot liquid to the overhead liquid distributor **60** in flow patterns assuring uniform flow through the entire fill assembly for most efficient cooling tower operation, and accomplishes this without inclusion of any overhead, horizontal feeder piping, and with the riser **56** located inwardly of the fill assembly in disposition to deliver liquid vertically into the inlet flume without creating boiling of liquid therein. The riser **56,** collection box **58,** flume **78** and distributor **60** are all precast concrete elements which are sufficiently massive in weight so as to remain in place upon the fill assembly framework **36** without being rigidly fastened thereto. Accordingly, assembly of the cooling tower is drastically simplified, requiring only that the several elements be lifted into place by construction equipment.

Preferably, collection box **58** is sized to cause the necessary reduction in liquid vertical velocity at normal liquid inlet flow rates. Upon occasions when larger than normal flow rates are being handled by the cooling tower, cover **86** is effective in assisting in reducing the vertical velocity of the liquid. In particular, the liquid entering the flume through inlet port **79** will impinge upon the lower face of cover **86** so that the latter acts as a baffle assisting in tending to spread the liquid uniformly horizontally throughout the flume. Preferably, therefore, cover **86** overlies the entire collection box **58** and portions of flume **78** proximal thereto, and is disposed with its lower surface located slightly above depression **80.**

When it is desired that the liquid be returned to the power plant still in a heated condition, gate **98** may be shifted vertically upwardly to allow bypass hot liquid flow through opening **96** for gravitation directly back to the underlying collection basin **34** in bypassing relationship to the fill assembly **38.** The elevated disposition of opening **96** assures maintenance of a positive back pressure upon riser **56** and inlet pipe **50** to preclude formation of cavitation conditions at the pumping means (not shown) which force the liquid to the cooling tower. Positioning of opening **96** in the wall of collection box **58** wherein the liquid collects and comes to a relatively calm condition prior to passage into inlet flume **78,** assures substantially complete liquid bypass on the fill assembly. Without collection box **58,** it will be apparent that portions of the liquid, even with gate **98** in its open position, would boil upwardly past opening **96** and ultimately into distributor **60.** The arrangement of vertical gate **98** presents an economical bypass flow control valve with drive means **104** therefor disposed at an easily accessible location above the inlet flume at walkway **88.**

During cold weather operation the external atmosphere around air inlet louvers **44** and above distributor **60** and flume **78** may be saturated with a fine spray of liquid that is capable of icing over air inlet louvers **44** to restrict the flow of air into the fill assembly. To deice louvers **44** when necessary, it is therefore desirable to fill outer basin **74** so that the hot liquid may overflow outer wall **68** and cascade along the louvers as depicted in FIG. **5.** To accomplish this, the bladders **114** of the several valve means **108** may be pneumatically inflated to allow full liquid flow to the several conduits **94.** If necessary, substantially the entire inlet liquid flow may pass through the several conduits **94** to fill basin **74** and cascade along louvers **44** to deice the same. By varying the pressure of air supplied to bladders **114,** the latter can be inflated to the extent desired to locate plate **110** in positions intermediate its minimum and maximum flow position, thereby variably restricting flow through conduit **94** as desired. To reduce flow through a conduit **94,** pressure in the associated bladder **114** is reduced, and the natural resiliency thereof causes contraction of the bladder and shifting of plate **110** to a more closed position.

The bladder actuator **114** is also exposed to a fine spray of cold liquid which tends to form a film of ice on the bladder. The resilient nature of bladder **114** allows it to be readily expanded when pneumatic pressure is applied thereto to break any ice film formed thereon. Upon relieving pneumatic pressure from the interior of bladder **114,** the natural resiliency thereof causes the bladder to shift plate **110** to a closed position, again readily breaking any films of ice formed on the bladder. Accordingly, films of ice collected upon the external surface of bladder **114** are broken up each time the bladder expands or contracts, thereby preventing the actuating mechanism from freezing solid. It is to be noted that plate **110** is disposed within conduit **94** so that the normal flow of liquid therethrough to outer basin **74,** tends to move the plate to its minimum position so that the liquid flow through the conduit assists the natural resiliency of the bladder in closing the valve means.

I claim:

1. For use with a cross-flow cooling tower provided with a fill assembly having an air inlet face and an air outlet with inner and outer portions therebetween for serial passage of air therethrough:

horizontally adjacent, inner and outer hot liquid distribution basins defined by spaced inner and outer sidewalls and respectively overlying said inner and outer portions of the fill assembly for receiving and distributing hot liquid to be cooled to respective portions;

liquid supply means including an open-top, liquid collecting flume located inwardly of said inner distribution basin and having a common sidewall therewith for supplying liquid to said inner distribution basin when liquid collects in said flume to a level overflowing said common sidewall prior to subsequent gravitation of the liquid to said inner portion of the fill assembly; and

a conduit interconnecting said flume and outer distribution basin for delivery of fluid to the latter,

said conduit being in communication with said flume at a level therein below the level at which liquid overflows said common sidewall, whereby liquid is uniformly delivered to said outer distribution basin during all liquid cooling operations of said tower.

2. A cooling tower as set forth in claim **1,** wherein is provided valve means in said conduit for variably restricting flow therethrough to said outer distribution basin.

3. A cooling tower as set forth in claim **1,** wherein said outer distribution basin has an outer sidewall of less height than said common sidewall, said conduit being of a size capable of delivering liquid to said outer distribution basin at a rate causing sufficient overflow thereof over said outer sidewall to impede collection of ice in blocking relationship to the air inlet opening.

4. A cooling tower as set forth in claim **3,** wherein is provided a series of horizontal air inlet louvers located across said air inlet face of the fill assembly and positioned in vertically staggered relationship with the lowermost margin of each louver located above an area of the louver therebelow intermediate the longitudinal margins thereof, said series of louvers being inclined in the direction of airflow and the uppermost louver being located below said outer sidewall of the outer distribution basin whereby liquid overflowing said outer sidewall cascades down the series of louvers.

5. A cooling tower as set forth in claim **1,** wherein said liquid supply means further includes a liquid collection box and a generally upright riser disposed in stacked relationship directly beneath said flume and registering therewith whereby liquid is delivered generally upwardly from said riser through said collection box to said flume, said collection box being of a size and configuration to reduce the vertical velocity of the liquid prior to entry thereof into said flume to an extent to allow substantially uniform distribution and collection of liquid throughout the length of said flume.

6. A cooling tower as set forth in claim **5**, wherein is provided a liquid collection basin underlying said collection box and the fill assembly for collecting liquid gravitating through the latter, said collection box having an opening therein allowing escape of liquid from said liquid supply means for gravitation to said collection basin in bypassing relationship to said inner and outer distribution basins and the fill assembly, and wherein is provided means for controlling liquid flow through said opening.

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