

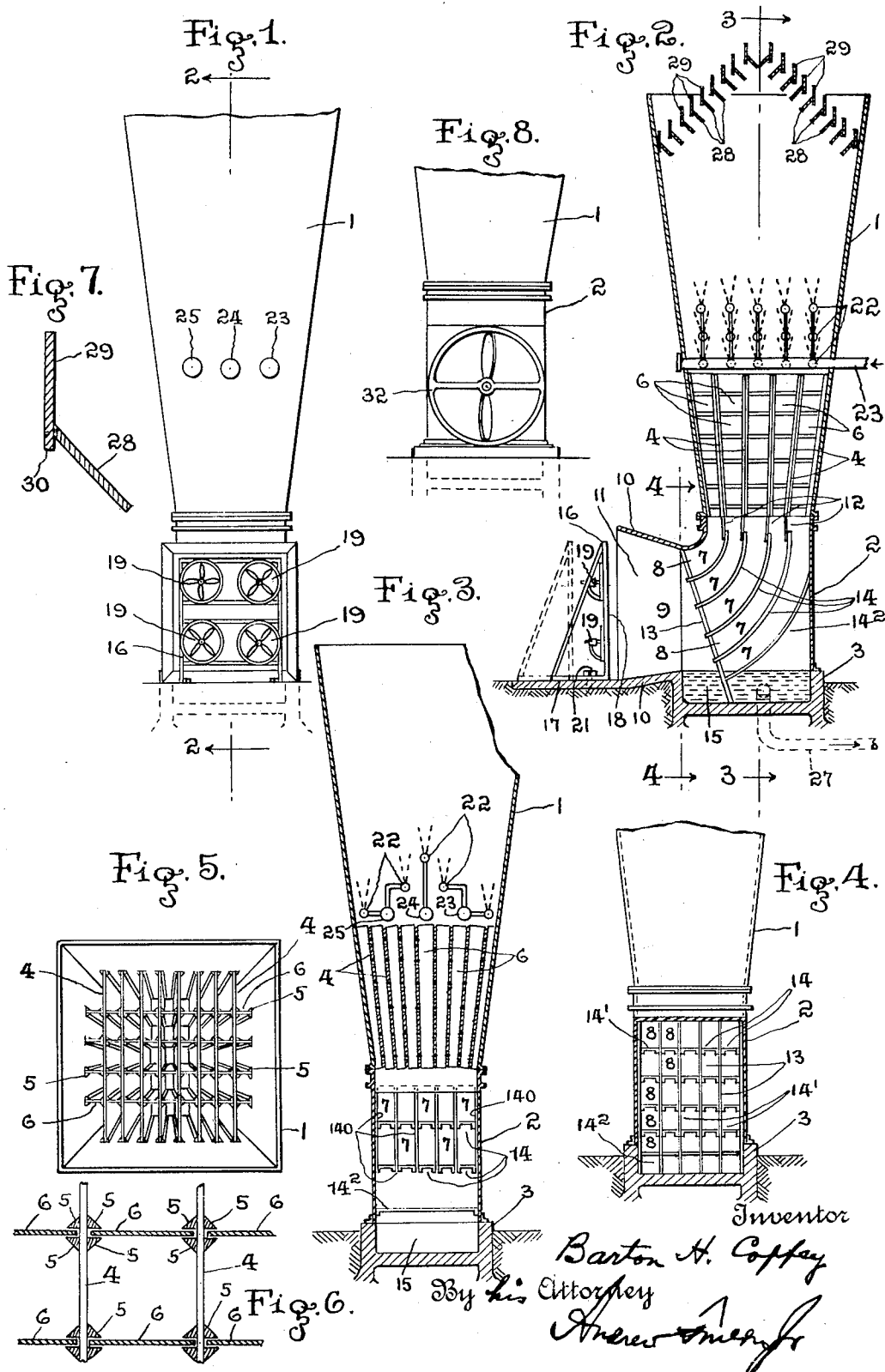
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COOLING TOWER

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COOLING TOWER

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My invention relates to improvements in mechanical draft water-cooling towers and particularly to that type of tower described in Letters Patent No. 1,762,762 issued June 10, 1930 in which the shell is a Venturi diverging tube which gradually reduces the high air velocity, at the throat, to low velocity, at the outlet, resulting in the recovery of a substantial part of the energy of the entering air, with corresponding reduction in power requirements.

I have found in practice that the use in the structure of fixed cooling surface in addition to that of the Venturi tube walls is advantageous in supplementing the cooling surface and that, if properly designed, the increased friction is small compared with the gain in efficiency.

Among the objects of my invention are to provide an efficient cooling tower, to simplify the operation of the said type of cooling tower, to gain higher cooling and mechanical efficiency, and to adapt the apparatus more fully to the modern and improved forms of fans and blowers now available.

I attain these and other objects by my invention, a preferred embodiment of which is illustrated in the accompanying drawing, it being understood that changes and modifications may be made therein without departing from the spirit of my invention.

In the accompanying drawing,

Figure 1 is an elevation of a cooling tower embodying my invention, viewed toward the air inlet;

Figure 2 is a vertical section on the center line 2-2 of Figure 1;

Figure 3 is a section on the line 3-3 in Figure 2;

Figure 4 is a section on the line 4-4 in Figure 2;

Figure 5 is a plan view of Figure 1, looking down the Venturi tube with the eliminators pipes and nozzles removed and showing the upper edges of the added cooling surface;

Figure 6 is an enlarged detail of the added cooling surface;

Figure 7 is an enlarged sectional detail of the eliminators; and

Figure 8 is a modification of the fan and air inlet.

Similar characters of reference refer to similar parts throughout the several views.

By the term "Venturi draft cooling tower" as used by me in this specification is meant a stack or vertical conduit for the atmospheric cooling of water or liquids, having diverging walls set at

an angle which will cause it, when working at atmospheric pressure, to produce at the throat or small end a pressure below that of the atmosphere. With liquid and gas streams there is a critical angle beyond which failure to function is abrupt.

The vertical diverging tube has special properties not possessed by the general family. For water discharging at atmospheric pressure the critical angle is 7.5° (included angle), at greater angles the jet jumps free and the discharge coefficient drops from 1.6 to 1.00. That is when running full, the discharge is about 60% greater than the theoretical discharge of the small end, due to reduced pressure at that point.

For air at atmospheric pressure, the critical angle is 60° and the conversion efficiency zero. At 70° conversion efficiency the included angle is $11^\circ 25'$. By this is meant that at this very slight angle the draft velocity is changed, say, from 3000 feet per minute at the throat or small end to 300 feet per minute at the large end, very gradually and evenly resulting in a pressure below atmosphere or minus static, at the throat. Efficiency is somewhat improved by providing a converging entry for the fan blast hereinafter described. The reduced pressure in the throat decreases the static pressure opposed to the fan blast and correspondingly reduces the power required to operate the fan.

The shell or stack 1 of the device, which may be suitably braced in any desired manner, is a vertical diverging Venturi tube preferably of lumber, mounted upon a steel base 2 which is in turn supported by and secured to a concrete foundation 3 with joints made air tight to prevent leakage into the tower which might otherwise result from a minus static pressure therein.

The lower part of the interior of the shell 1 is preferably provided with spaced fixed cooling surfaces of lumber set vertically therein and approximately parallel to the side walls of the shell 1. For this purpose I prefer to provide a series of battened lumber partitions comprising vertical walls 4 with triangular battens 5 and spaced separators 6. The separators 6 are spaced, in the plane of the partition, a distance dependent upon the service required. The battens 5 are attached in pairs and spaced to form a groove therebetween to take the separators 6, which fix the spacing of the partition walls 4 as shown in Figures 5 and 6. Grooves are also formed by battens in like manner on the inner face of the shell 1 to take the marginal edges

of the partitions 4 and of the extreme separators 6.

The whole assemblage of partitions and separators is thus held rigidly in position and can easily be removed for cleaning and repairs.

The materials of construction as specified above are preferred, but either metal or lumber are practicable and metal is preferable under some conditions of service.

As the walls of the Venturi tube 1 diverge, it will be apparent that the spaced partitions 4 and separators 6 therein which are approximately parallel to the walls of the tube 1 will form vertical tapered tubes.

At the lower ends of the vertical tapered tubes thus formed by the partitions 4 and separators 6, I provide curved air passages 7, terminating in open mouths 8 opening toward the open air inlet 9 of the base 2 which is provided with flaring skirt plates 10 forming a flaring open mouth 11.

These curved air passages 7, 7 form curved continuations respectively of the vertical tapered tubes formed by the partitions 4 and separators 6 and are preferably formed by bent strips of wood or metal attached at their upper ends to plates 12 which support the partitions 4.

I preferably form these curved air passages 7 by means of bent channel plates or bars 14 attached to the plates 12 and which extend therefrom in a curved sweep to flat metal struts 13 which support the outer ends of the plates 14 and separate them by the thickness of the struts 13, thus forming slots 140 in the vertical plane between adjacent channel plates 14 and between the side channels 140 and the adjacent walls of the base 2. Other constructions may be used to form the slots. At the rear of the channels 14 I provide a curved plate 14² which is tight to the walls of the base 2 at side margins and back, and serves as a seal.

As is evident, these slots 140 in direct vertical line will convey a large percentage of the total flow or drip in a direct vertical drop to the seal plate 14² and thence direct to the tank 15, at the base, where the cooled water is collected as shown in Figures 2 and 3, thus forming a plurality of walls of descending water parallel to the air stream and between which the air has free passage. Many substantial advantages accrue from this construction, the moving walls of water form cooling surface of the most active kind; the large quantity of water descending is so disposed as to minimize its retarding effect upon the ascending air stream; the reception of equal parts of the air supply by the passages 7 and its practically uniform distribution over the horizontal throat area of the Venturi tube where the air enters the fixed cooling surface; an easy turn of the air stream from horizontal to vertical; the curved passages 7 within the air tight base 2, while forming an extremely efficient elbow for the air stream, removes the slightest possibility of water entering the air piping; the tapered tubes forming the fixed cooling surface cause the air to lose velocity as it flows through them in accordance with the requirements of the Venturi efficiency effect.

In front of the open mouth or air port 11, I provide a carriage 16 preferably comprising a base 17, fan carrier 18 with fans 19 thereon, and struts 20. This carriage 16 is adapted to be moved towards and away from the open mouth 11 of the air inlet of the tower, and may be secured in any desired location by means of a bolt 21 or in any desired manner. Two positions

of the fan carrier are shown as indicated by dotted lines in Figure 2.

The fans 19 may be of any desired type and number. I prefer to use the propeller type of fan which is directly driven by electric motor with the usual connections.

In the shell or stack 1, above the cooling surfaces 4, 6, I provide a series of spray nozzles 22 to which water to be cooled is supplied by mains or supply pipes 23. The number and arrangement of the nozzles 22 may be varied as conditions may require. A preferred arrangement is illustrated in the drawing, and comprises a series of three water supply pipes 23, 24, 25 within and extending across the shell 1 and each carrying a series of nozzles 22 so spaced and arranged as to distribute the water evenly in the form of fine spray throughout the space within the tower. This spray cools rapidly and accounts for a substantial part of the total heat transfer. In the arrangement of nozzles shown in the accompanying drawing I have provided three spaced and parallel water supply pipes 23, 24 and 25. The outer pipes 23 and 25 each carry a plurality of spray nozzles 22. One series of nozzles adjacent the side walls being in a plane horizontal to the pipes 23 and 25 and the other series being on a higher plane. The central supply pipe 24 carries a series of spaced nozzles 22 at a still higher plane. When the spray particles from these nozzles 22 reach the limit of their height above the nozzle tips they descend in a uniform shower upon the partitions 4 and separators 6, and run down these cooling surfaces in thin sheets, and thence to the curved air passages 7 being subjected to the cooling effect of the air currents in its descent. In the curved air passages 7 the water may pass and fall through the air spaces 140 as above explained and it passes thence to the reservoir or tank 15 at the bottom of the tower, from which it is drawn off through the drain 27.

The cooling of the water is caused by currents of air supplied to the tower by the fans 19 in which I employ the principle of inductive jets; in this case the jets are the discharges from the fans 19, adjusted with reference to the open mouth 11 of the tower and the fans may be moved toward and away from the open mouth until the point of maximum operating efficiency is found.

As the jet of air leaves the fan 19 at high velocity it entrains by friction the surrounding air through which it passes and a large volume of air is thus formed and drawn into the tower, exceeding the weight which is delivered directly by the fans 19.

The currents of air thus entering the tower pass through the curved air passages 7 and the tapered tubes formed by the partitions 4 and separators 6 and cool the water passing down in thin sheets over the cooling surfaces. The cooling effect is further increased by spacing apart the boards 4 forming partitions so that the air may pass horizontally from tube to tube thus equalizing pressure and the water dripping from board to board will be efficiently subjected to the cooling effect of the air.

The lowermost part of the curved partition 14² is preferably at or below the normal water level in the tank 15 and thereby prevents eddies between the edge of the partition 14² and the back wall of the base 2.

At the top or upper portion of the shell 1, I provide moisture eliminators to minimize the

waste of water which might otherwise be blown out of the top of the tower.

The eliminators comprise a plurality of spaced parallel boards or plates 28 positioned at an angle of approximately 45° to the horizontal plane and a second series of boards or plates 29 positioned vertically and offset thereon so that a depending vertical lip 30 is formed at the point or angle and the whole assembly is framed and positioned at an angle of approximately 45° to the horizontal as illustrated in Figure 2.

As the air stream lines in the tower are approximately vertical, they are turned through an angle of about 45° in passing between the adjacent plates 28 and the major part of the contained fine spray drops are deposited, due to their velocity and inertia, upon the windward sides of the surfaces 28. The drops coalesce to a film which is checked in its upward motion by the lip 30 and drops from thence to the lee side of the next plate 28 below and from thence through the tower. On leaving the plates 28 the air streams are again turned through an angle of 45° to the vertical and any remaining spray coalesces on the vertical windward surfaces of the plates 29 and trickles down to the upper surface of the plates 28 and from thence to the cooling surfaces within the tower. The construction shown is wood but the eliminators can be made in one piece of continuous bent metal as their function depends upon shape and not upon materials of construction.

The tower can be operated efficiently by fans without induced air currents in conformity with standard forced draft tower practice as indicated by Fig. 8 in which a single large fan 32 is shown as a source of the air supply discharging directly into passages 7.

Having thus described my invention, what I claim is:

1. In a mechanical draft cooling tower, the combination of a plurality of vertical diverging tubular draft passages within the tower and terminating in curved passages at their lower ends, means for delivering a current of air at the lower ends of the passages, said means comprising an air inlet adjacent the base of the tower, a fan adjacent the said inlet and spaced therefrom, and means for adjustably positioning said fan toward and from said air inlet, means for delivering spray above the draft passages, and means for collecting the water at the base of the tower.

2. In a Venturi draft cooling tower, the combination of a plurality of tapered tubular draft passages therein, partitions and separators forming the walls of the said draft passages, equalizing openings in said walls and means for supplying a current of air at the lower ends of said draft passages said means comprising an air inlet adjacent the base of the tower, a fan adjacent the said inlet and spaced therefrom, and means for adjustably positioning said fan toward and from said air inlet.

3. In a Venturi forced draft cooling tower, a base of air tight construction having a side air inlet and a top opening and a bottom opening,

said base being supported by and in air tight contact with a receiving tank, means for turning an air stream flowing through said base from approximately horizontal at said air inlet to approximately vertical at said top opening and means for conducting walls of free falling water parallel to said air stream from said top opening through said bottom opening to said receiving tank.

4. In a cooling tower, the combination of a vertically disposed Venturi diverging tube, a plurality of vertical partitions therein having spaced side walls and forming diverging air passages, an open mouth adjacent the base of said tower, a plurality of spaced curved plates intermediate said air passages, and said mouth, means for discharging water in the form of spray above said air passages, a collecting tank at the base of the tower, a curved seal plate disposed rearwardly of said first mentioned curved plates, a fan adjacent the said open mouth of the tower adapted to supply a current of air to the tower and means at the discharge end adapted to eliminate moisture, said means comprising a plurality of vertical plates in combination with plates disposed at an angle thereto and a depending lip on the said vertical plates.

5. In a mechanical draft cooling tower, the combination of a stack, an air inlet port adjacent the base of the stack, a fan adjacent said air inlet and spaced therefrom, a fan carrier for said fan, means for moving said fan carrier and fan toward and from said air inlet, and means for detachably securing the fan carrier in a fixed position.

6. In a mechanical draft cooling tower, an air outlet, moisture eliminators adjacent said air outlet and comprising a plurality of spaced parallel plates positioned at an angle of approximately 45 degrees to the horizontal plane and a second set of plates positioned vertically and offset on said first named plates, the marginal edge of said vertical plates forming a depending vertical lip extending below the intersection of said plates and forming an inverted open gutter and checking lip and means for discharging water above said tubular passages.

7. In a vertical mechanical draft cooling tower having diverging walls, the combination of a stack, an air inlet port adjacent the base of the stack, a fan adjacent said air inlet and spaced therefrom, a plurality of vertical, diverging, tubular draft passages within the stack and terminating in curved passages at their lower ends, means for delivering spray above the draft passages, means for collecting water at the base of the stack, moisture eliminators adjacent the outlet of said stack and comprising a plurality of spaced parallel plates positioned at an angle of approximately 45 degrees to the horizontal plane and a second set of plates positioned vertically and offset on said first named plates, the marginal edge of said vertical plates forming a depending vertical lip extending below the intersection of said plates and forming an inverted open gutter.

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