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[54] **AIR-COOLED CONDENSATION APPARATUS**

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[51] **Int. Cl.** **F28b 3/00**

[58] **Field of Search** 165/111, 122

[56] **References Cited**

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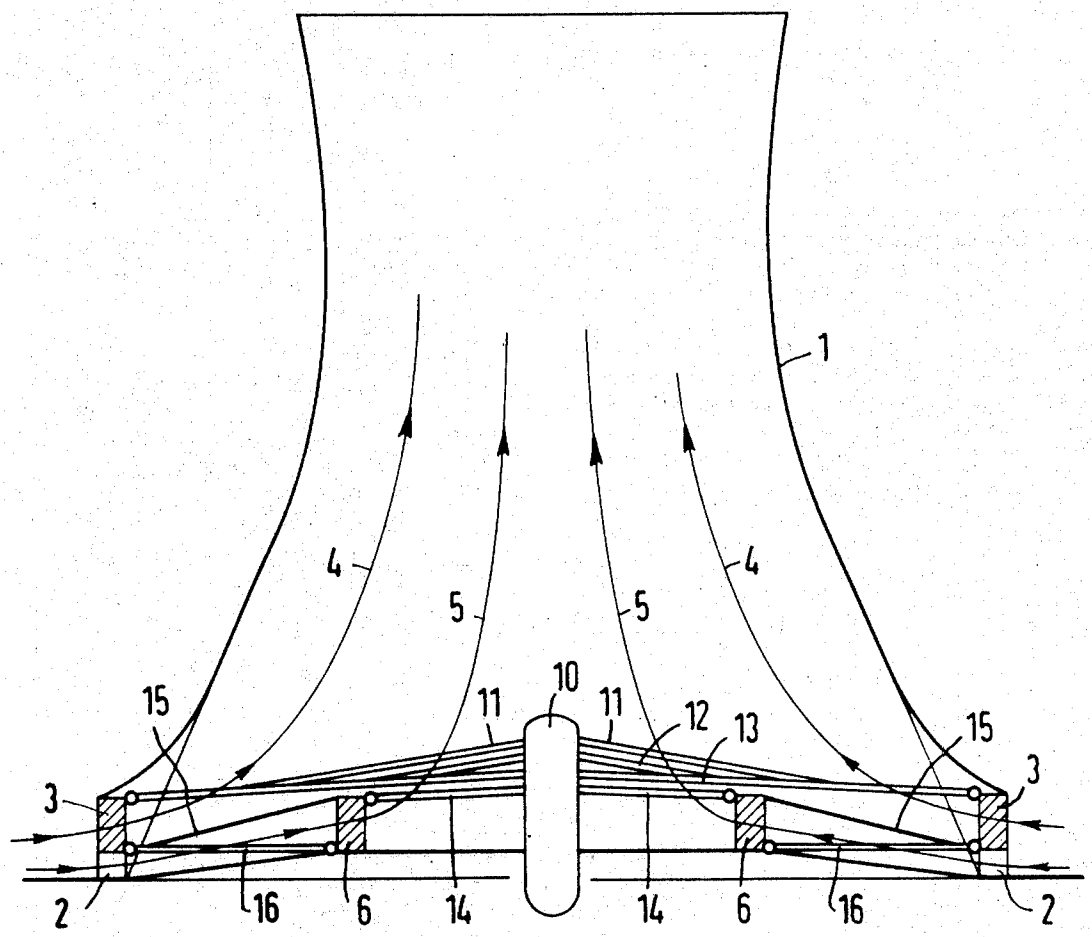
[57] **ABSTRACT**

In air-cooled condensation apparatus having a natural-draft cooling tower, condensation elements are disposed not only at the outer periphery of the cooling tower but also in at least one ring located in the interior of the cooling tower coaxially to the condensation elements at the outer periphery, the cooling elements located in the interior of the cooling tower being operable in winter dephlegmatorically, i.e., with steam flowing into the cooling tower from below.

7 Claims, 4 Drawing Figures



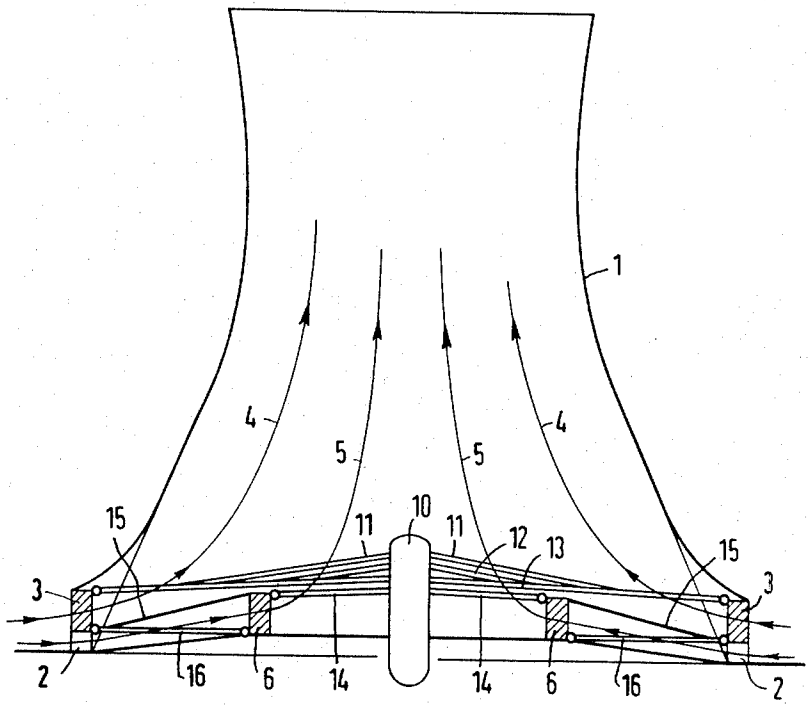


Fig. 1

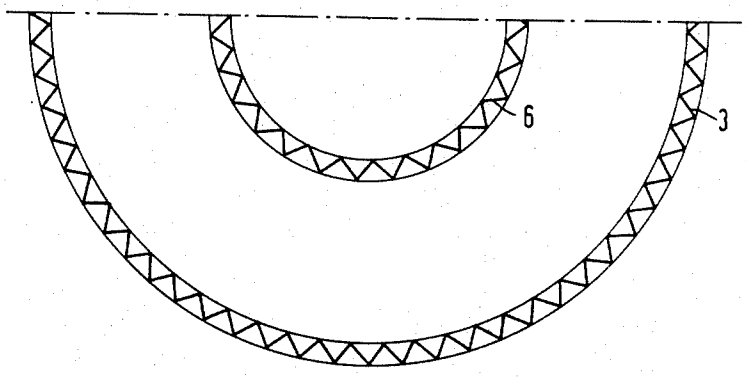


Fig. 2

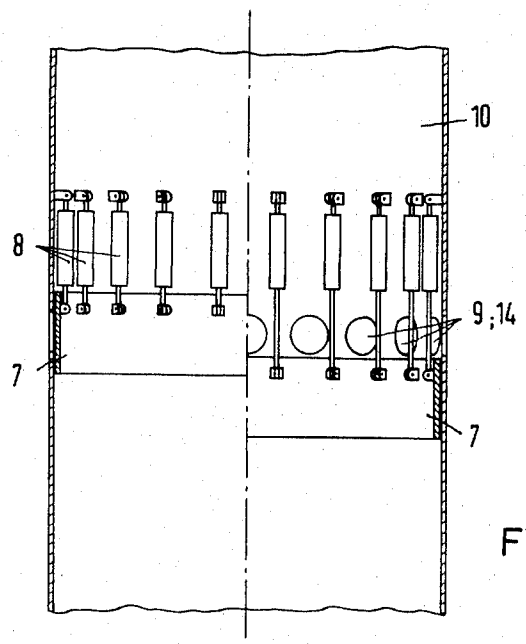


Fig. 3

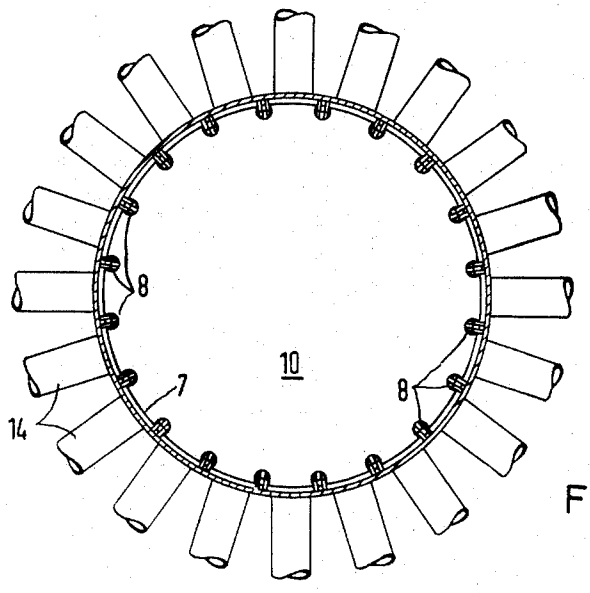


Fig. 4

AIR-COOLED CONDENSATION APPARATUS

The invention relates to air-cooled condensation apparatus having a natural-draft cooling tower for steam power plants or the like. More particularly, the invention relates to such condensation apparatus wherein condensation elements are disposed along the periphery of the base region of the cooling tower.

It is an object of the invention to provide air-cooled condensation apparatus which have a single cooling tower sufficient enough for large power plant blocks, wherein the cooling surface elements are installed at the bottom of the cooling tower in such a way that they are subjected to the steam flow uniformly and the warm air rises with a temperature that is as equal as possible over the entire cross section of the cooling tower in order to generate optimum draft conditions. In this connection, different conditions for high and low air temperatures must be taken into consideration and, above all, a possible danger of icing must be anticipated.

With the foregoing and other objects in view, there is provided in accordance with the invention, in air-cooled condensation apparatus for steam power plants, a natural-draft cooling tower having at least two groups of condensation elements, one of the groups being disposed at the base of the cooling tower along the outer periphery thereof, and the other of the groups being disposed along a circle located within the cooling tower and coaxial to the outer periphery of the cooling tower. When the cooling surfaces are disposed in concentric or coaxial circles in the lower part of the cooling tower, it is possible to connect the outer or the inner cooling ring zones in winter dephlegmatorically to the inner condensation elements or to those disposed at the outer periphery, respectively.

In accordance with another feature of the invention, the condensation elements located at the outer periphery of the cooling tower are mounted on supports or are located by any other means at an adequately high level that, parallel to a cooling air flow passing through the condensation elements at the outer periphery, an additional cooling air flow for the condensation elements disposed in the interior of the cooling tower can pass beneath the condensation elements at the outer periphery. The air supply to the condensation elements located in the interior of the cooling tower is assured by the suitable disposition of appropriate flow guide surface members.

In accordance with a further feature of the invention, steam that is to be condensed is supplied to the individual condensation elements by radially extending steam lines, from a distributor disposed at a central location of the cooling tower.

In accordance with an added feature of the invention, a feed line supplying steam to the distributor as well as the individual, radially extending steam lines to the condensing elements are slightly inclined downwardly in direction of flow of the steam therethrough so that condensate formed therein is collectible at definite locations and is dischargeable therefrom.

In accordance with an additional feature of the invention, and due to the fact that the condensatiOn elements in the condensation apparatus are separated into two or more concentric or coaxial groups, operation thereof can be effected selectively with normal condensation of steam introduced from the top of the cooling tower, or by a dephlegmatoric connection wherein

steam is supplied from below to the deplegmatorically connected condensation elements in a direction that is entirely or predominantly opposite to the direction of condensate discharge. Thus, the inner cooling ring zones can be operated dephlegmatorically in winter, for example, whereas during the summer, all of the condensation elements are supplied with steam from the top of the cooling tower, so that the condensate then flows downwardly in the same direction as that of the steam. In winter operation, the steam that is not condensed in the outer peripheral condensation elements of the cooling tower is subsequently reintroduced from below to the condensation elements disposed in the interior of the cooling tower, the steam that is normally supplied from above, being then shut off.

In order to switch over from normal condensing operation to dephlegmatoric operation, there is provided, in accordance with another feature of the invention, a cylindrical ring located within the central steam supply, i.e., in a steam distributor, the cylindrical ring being displaceable so as to close off simultaneously the inlets to steam lines disposed in a common plane and extending from the steam distributor to the condensation elements that are to be operated dephlegmatorically. If the steam lines from the steam distributor are disposed in different planes, the displaceable cylindrical ring is made with corresponding recesses or openings.

The invention of this application affords an improvement in the air flow for natural-draft cooling towers of relatively large diameter, because cooling air can now be supplied thereto not only at the outer edge but also in the inner part thereof and, due to the air that is also heated there, a corresponding updraft is generated. The draft action is thereby markedly increased.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in air-cooled condensation apparatus, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a diagrammatic vertical sectional view of a cooling tower constructed in accordance with the invention;

FIG. 2 is a diagrammatic bottom plan view of half of FIG. 1;

FIG. 3 is an enlarged fragmentary sectional view of FIG. 1 showing the steam distributor containing a displaceable cylindrical ring which, in the left-hand side of the figure is in a different phase position thereof than in the right-hand side of the figure; and

FIG. 4 is a cross-sectional view of FIG. 3 taken along the line III—III in the direction of the arrows.

Referring now to the drawings, and first particularly to FIGS. 1 and 2 thereof, there is shown therein, in an air-cooled condensation apparatus, a cooling tower 1 mounted on supports or legs 2 which are so positioned beneath a group of condensation elements 3, that are

disposed along the outer periphery of the cooling tower in a zig-zag manner, that additional cooling air can enter into the interior of the cooling tower. The air flow passing through the group of condensation elements **3** travels fundamentally in the direction represented by the arrows **4**, while underneath the same, the air flow travels in the direction represented by the arrows **5** through the inner cooling elements **6**. The latter may also be disposed in a zig-zag manner along one or more mutually concentric or coaxial circles. By means of suitable guide surface members **15**, the air flow is directed substantially in the direction represented by the arrows **5**, so that virtually the entire interior volume of the cooling tower **1** is occupied by the heated air flow, which consequently produces a strong natural draft action.

Exhaust steam is fed from a centrally disposed distributor **10** through a multiplicity of substantially radially extending groups of feed pipes or supply lines **11, 12, 13** and **14** to the groups of condensation elements **3** and **6**.

Whereas, in normal operation, the steam that is to be condensed is fed to the individual condensation elements **3** and **6** from above, as viewed in FIG. **1**, the so-called dephlegmator connection provides for the steam to be introduced entirely or mainly into the condensation elements from below, in a direction opposite to the flow direction of the discharging condensate. Thus, for example, the feed pipes **16** extend to the lower end of the condensation elements.

In the embodiment shown in FIGS. **1** and **2**, the supply of steam can be controlled so that initially only the inner condensation elements **6** or the outer condensation elements **3** are provided with a normal steam supply from above, while the succeeding condensation apparatus **6** is operated dephlegmatorically so that the steam fraction not yet condensed in the preceding condensation elements **3** is conducted downwardly and is fed to the subsequent dephlegmator elements from below through the lines **16**.

The steam lines **11** to **14** are advantageously installed at a predetermined inclination extending downwardly from the inside to the outside of the cooling tower **1**. Just ahead or upstream of the condensation elements, devices for the discharge of the condensate may be provided for improving the heat transfer conditions in the cooling surfaces. The condensate manifolds which are not shown in detail in the drawing, can advantageously also be installed with a downward inclination.

In FIGS. **3** and **4**, the means for controlling the flow of steam through the steam distribution lines from the distributor **10** to the condensation elements are illustrated. In order to eliminate the danger of freezing, at low temperature the condensation elements **6** disposed along the inner coaxial or concentric circles can be connected dephlegmatorically to the condensation elements **3** disposed at the outer periphery. All of the exhaust steam is then conducted from the distributor **10** through the substantially radially extending feedlines exclusively to the upper distributor manifolds of the condensation elements **3** that are disposed at the outer periphery of the cooling tower, the steam not condensing thereat being conducted through correspondingly radially disposed horizontal connecting lines **16** to the lower manifolds of the inner cooling elements **6** which are disposed in concentric or coaxial rings. The steam which flows upwardly thereat prevents the condensate from freezing to the walls.

Within the cylindrical distributor **10**, as illustrated in FIGS. **3** and **4**, a vertically displaceable ring **7** is mounted. The ring **7** can be raised or lowered by means of hydraulic cylinders **8**, so as to open and close thereby openings or inlets **9** for the feed lines **14**. It is accordingly possible to shut off the steam supply to the upper manifolds of the condensation elements **6**. On the left-hand side of FIG. **3**, the openings **9** are shown in closed condition, whereas they are shown in open condition on the right-hand side of the figure. The condensation elements **6** then receive their steam through the connecting lines **16**.

I claim:

1. In air-cooled condensation apparatus for steam power plants, a natural-draft cooling tower having at least two groups of condensation elements, a first of said groups being disposed at the base of the cooling tower along the outer periphery thereof, a second of said groups being disposed along a circle located within the cooling tower and coaxial to the outer periphery of the cooling tower, means for disposing said first of said group of condensation elements at an elevation parallel to a cooling air flow passing through said condensation elements at the outer perphery, thereby enabling an additional flow of cooling air directed to said first group of condensation elements disposed in the interior of the cooling tower to pass beneath said first group of condensation elements at the outer periphery.

2. Apparatus according to claim **1** wherein said disposing means comprise support members whereon said first group of condensation elements located at the outer periphery are mounted.

3. Apparatus according to claim **1** including flow guide surface means mounted in the cooling tower for guiding the additional cooling air flow to said condensation elements disposed in the interior of the cooling tower.

4. Apparatus according to claim **1** wherein a plurality of steam lines extend from a steam distributor to said first of said condensation elements in a downwardly inclined position.

5. Apparatus according to claim **1** including control means for selectively operating said outer condensation elements and said inner condensation elements dephlegmatorically.

6. Apparatus according to claim **5** including a steam distributor disposed within the cooling tower and a plurality of steam lines extending from said distributor to said condensation elements, said control means comprising a cylindrical ring disposed within said steam distributor, said ring being displaceable so as to close respective inlets to said steam lines.

7. Apparatus according to claim **6** including hydraulic means disposed in said steam distributor for displacing said cylindrical ring into and out of positions wherein inlets to said steam lines are selectively opened and closed.

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