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PATENT SPECIFICATION

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(54) A COOLING TOWER

(71) We, SHINWA SANGYO CO. LTD., a Japanese Company of No. 8, 4-chome, Nishi-Hacchobori, Chuo-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an improved cooling tower of the kind in which cooling of a fluid occurs whilst the fluid is flowing over a series of corrugated cooling plates.

In one known form of cooling tower the corrugated plates are secured between spacer plates of the same width and height as the corrugated plates in the tower. As a result the liquid to be cooled tends to collect, and be retained, in the corners formed between the spacer plates and the crests of the corrugations, with consequent reduction of the effective area of cooling.

In another known tower, cooling air is led into the bottom of the tower through louvres and this necessitates a large tower.

In yet another known tower a rotating sprinkler is provided with metal or plastics bearings which are lubricated with the liquid to be cooled and, because this liquid often contains dust, the bearings wear rapidly.

It is an object of the present invention to provide a tower in which these disadvantages are eliminated or at least reduced.

In accordance with the present invention there is provided a cooling tower comprising a filler block formed of bendable corrugated plates over the surfaces of which a liquid to be cooled can flow in heat exchange with air flowing through passages defined by the corrugations, wherein the plates are separated by linear spacer elements running across the crests of the corrugations whereby the pitch of the corrugations and hence the density of packing of the plates can be adjusted by adjusting the spacing of the spacer elements one from the next.

Preferably the plates are arranged on concentric cylinders to form a cooling block

with the crests running vertically and separated radially by the said spacer elements which are disposed around each cylinder across the crests of the corrugations whereby the pitch of the corrugations and the spacing of the spacer elements one from the next and consequently the density of packing of the block can be adjusted by adjusting the tension of each separator element.

Preferably the liquid to be cooled is passed into the tower by way of an inlet pipe passing axially through the said cooling block.

Preferred forms of the invention will now be described with reference to the accompanying drawings in which:—

Figure 1 is a diagrammatic axial sectional elevation of a tower;

Figures 2A, 2B and 2C are perspective views of portions of three possible arrangements of the cooling block used in the tower of Figure 1;

Figure 3 is an elevation, partly in section, of a portion of the tower shown in Figure 1; and

Figure 4 is an elevation, partly in section, of a portion of another tower.

The cooling tower 10 of Figure 1 comprises a vertical cylindrical shell 11, a sprinkler 12 which receives hot liquid to be cooled from a vapour condenser (not shown), a pipe 13 for conducting water from the condenser to the sprinkler, a blower 14 for blowing a cooling fluid, such as atmospheric air, up through the tower in counter-flow with the liquid to be cooled, a collector 15 for cooled liquid, a cooling block in the form of a plurality of cooling plates 16 arranged on concentric cylinders and over which the liquid to be cooled flows downwardly and between which, i.e. in the spaces defined by the corrugations, the cooling fluid (air) is passed upwardly, and a guide 17 for directing the cooled liquid which falls from the plates 16 into the collector 15.

At the upper end of the tube 13 is a connector 18 for connecting the fixed tube 13 with the rotating sprinkler 12 in such a

way that water to be cooled may be passed from the condenser, by way of the tube 13, into a plurality of sprinkler tubes 10 which extend radially, and in a horizontal plane, from the connector. The tubes 19 are formed each with several holes, offset a little from the underside of the tube, so that by reaction of the water issuing from holes the tubes are automatically rotated. Water to be cooled is in this way sprinkled on to the top of the cooling block constituted by the plates 16.

The blower consists of a motor 21 driving a fan 22 serving to force air through an opening 23, thence upwardly between the plates 16 and out to atmosphere again through an outlet 24. It will be seen that the hot water to be cooled passes down over the plates whilst the cooling air passes, in counter-flow with the water, upwardly between the plates.

The collector 15 is in the form of an annular trough and is disposed at the lower end of the tower. Cooled liquid which has passed down through the tower falls on a two-part conical guide 17, 17' by which it is directed into the annular collector 15.

From the collector the cooled liquid may be re-circulated to the condenser.

With this arrangement the blower 14 can be disposed inside the annular collector on the axis of the cylindrical cooling block of plates 16 so as to provide an efficient cooling system.

Each of the guide-parts 17 and 17' is in the form of a frustum of a cone. The upper one, 17', overlaps the lower one 17 which is formed with a central aperture. They are arranged coaxially, one above the other, so that all cooled liquid issuing from the bottom of the cooling block of plates falls on to the upper frustum 17', thence on to the lower one and finally into the collector. At the same time cooling air is blown by the fan as indicated by the broken line arrows, under and through the guide 17 up between the plates 16 and thence to atmosphere.

Figures 2A, 2B and 2C illustrate the cooling plates 16. A cooling block consists of a plurality of similar plates of the kind shown at 25 in Figure 2a. The plates are maintained in spaced relationship with the aid of horizontal linear spacer elements such as rods 26 which are disposed transversely of the corrugations. The crests 27 (or troughs) run vertically and are normally held at a constant pitch spacing as shown at P in Figure 2A.

The plates are bendable and preferably resilient and may be made for example of a synthetic plastics material, metal or paper. The pitch P may be varied by varying the spacing d of the spacer elements. Thus Figures 2A, 2B and 2C show arrangements

of progressively decreasing pitch or increasing density of packing.

The pitch is normally varied during the construction of the tower. By increasing the density of packing more plates can be used for a given volume and the effective surface area increased.

Figure 3 illustrates a mounting 30 for supporting the sprinkler tubes 19 so that they can be rotated on the top of the tower in bearings which are sealed against being wetted by the water passing through the tubes.

The pipe 13, the sprinkler tubes 19 and the sprinkler bearings are all connected by the connector 18.

The bearings comprise a vertical shaft 31 fixedly mounted on a perforated, conical upper end 32 of the pipe 13.

The pipe 13 also supports the connector 18 by way of a hollow cylindrical shaft 33 fixed to the connector 18 at its lower end and integrally rotatable with the several sprinkler tubes 19 which are disposed radially around the shaft 31.

The hollow shaft 31 is provided with upper and lower bearings 34 and 35, a drainage gap 36 being formed below the lower bearing 35 and a packaging 37 being disposed, below the lower bearing 35, between the shaft 31 and the roof-like top 32 of the tube 13, so as to prevent the liquid from leaking into the bearing 35. A drainage gap 38 is also provided between the tube 13 and the connector 18 so as to lessen friction due to rotation between these members as a result of water passing between them.

Referring now to Figure 4, which illustrates an alternative embodiment of the connector, the supporting means 40 for supporting the sprinkler tubes 19 are, as before, disposed on the connector 18 by way of a shaft 41 which is mounted on a roof-like top 42 on the upper end of the tube 13. A hollow cylindrical shell 43 which is integral with the connector 18 is formed with an internal groove 44 of rectangular radial section. The connector 18 is rotatable with the several sprinkler tubes 19 which are disposed radially and coaxially around the shaft 41. The weight of the tubes is taken by a sliding bearing ring 45 fixed on the shaft 41 at its upper end. The ring is thus free to slide between the underside of a cover 46 and the upper surface of the shell 43. The cover 46 is secured to the shell 43 with the aid of a screw 47 so as to form a dust-proof cover. The shaft 41 and ring 45 are preferably of metal whilst the connector 18 and cover 46 are preferably formed of a synthetic material. The bearing ring 45 is lubricated by water or other liquid which can pass from the pipes 19 through a clearance space provided between shaft 41 and connector 18.

Both of the cooling towers described operate in the following way:—

Relatively hot liquid to be cooled is passed from the condenser (not shown) through the tube 13, through the apertures in the perforated roof-like top 32 or 42 of the tube 13 by way of connector 18 into sprinkler tubes 19 from which the liquid is sprayed on to the cooling plates 16. The sprinkler holes in the tubes are so placed that, by reaction of the water issuing therefrom, the tubes are automatically rotated so that the liquid to be cooled is distributed over the whole cooling block consisting of the plates 16. Cooled liquid falling from the bottom of the plates 16 is thrown by the guides 17' and 17 into the annular collector 15 whence it may be re-circulated to the condenser. The cooling of the liquid occurs as a result of the relatively cold air blown by the fan 22 upwards between the cooling plates 16.

Owing to the annular shape of the collector, the tower as a whole is extremely compact and its life is relatively long because of its particular structure.

WHAT WE CLAIM IS:—

1. A cooling tower comprising a filler block formed of bendable corrugated plates over the surfaces of which a liquid to be cooled can flow in heat exchange with air flowing through passages defined by the corrugations, wherein the plates are separated by linear spacer elements running across the crests of the corrugations whereby the pitch of the corrugations and hence the density of packing of the plates can be adjusted by adjusting the spacing of the spacer elements one from the next.

2. A cooling tower as claimed in claim 1 wherein the plates are arranged on concentric cylinders to form a cooling block with the

crests running vertically and separated radially by the said spacer elements which are disposed around each cylinder across the crests of the corrugations whereby the pitch of the corrugations and the spacing of the spacer elements one from the next and consequently the density of packing of the block can be adjusted by adjusting the tension of each separator element.

3. A cooling tower as claimed in claim 2 comprising a plurality of radially arranged sprinkler tubes mounted above the block for rotation about the axis of the block.

4. A cooling tower as claimed in claim 3 wherein the sprinkler tubes are mounted for rotation on a bearing on the upper end of the said inlet pipe, means being provided for preventing liquid entering the bearing.

5. A cooling tower as claimed in any of claims 2 to 4 including an annular peripheral collector for the cooling water disposed under the cooling block and overlapping conical guide surfaces for guiding the water falling from the cooling block into the annular collector.

6. A cooling tower as claimed in claim 5 including a blower disposed centrally under the conical guide surfaces and arranged to blow air between and under the conical guide surfaces and subsequently through the cooling block.

7. A cooling tower substantially as described herein with reference to the accompanying drawings.

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