July 22, 1947. E. A. EDMONDS 2,424,441

WATER DISTRIBUTING FERRULE FOR VERTICAL TUBE HEAT EXCHANGERS

Filed Sept. 6, 1944

Fig. 1.

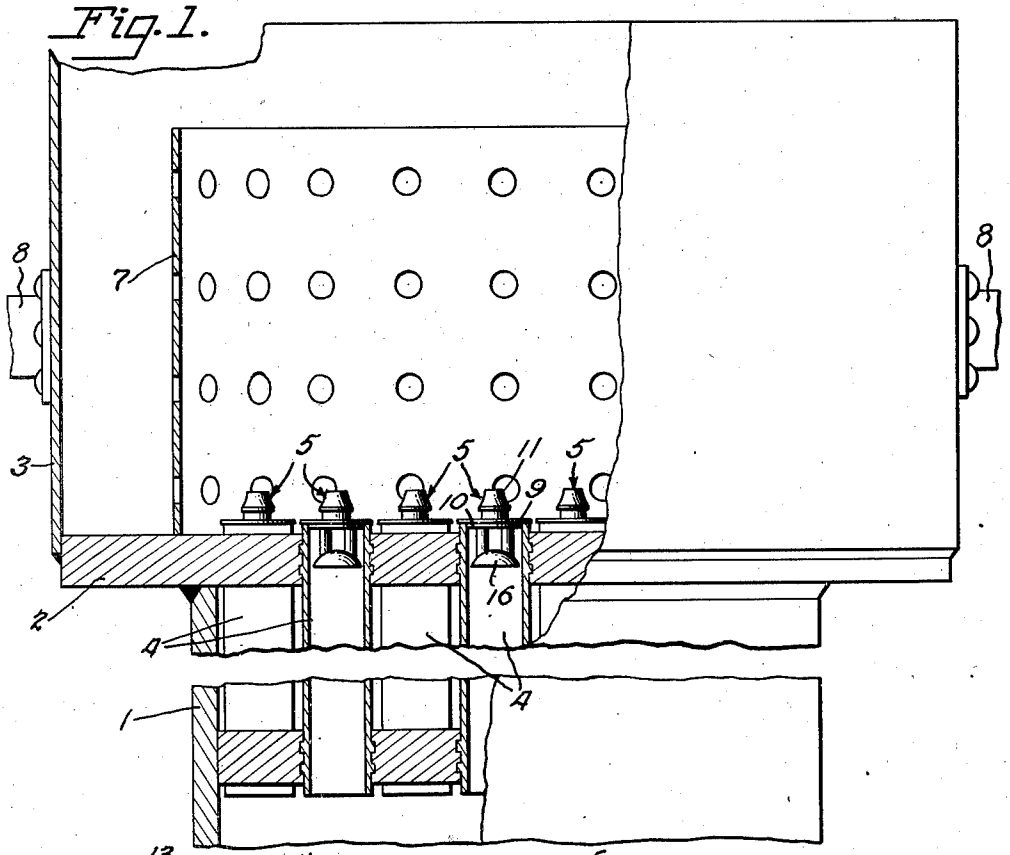


Fig. 2.

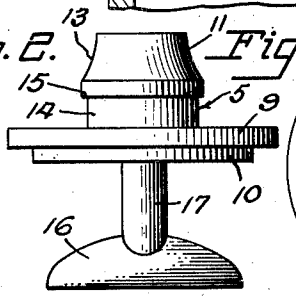


Fig. 4.

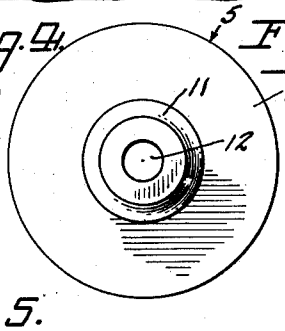


Fig. 3.

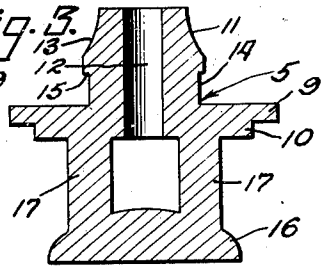


Fig. 6.

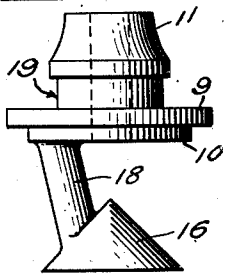
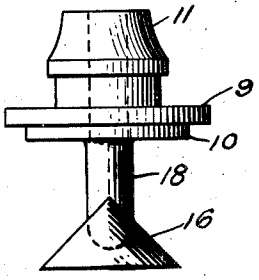


Fig. 5.



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WATER DISTRIBUTING FERRULE FOR VERTICAL TUBE HEAT EXCHANGERS

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3 Claims. (Cl. 138—38)

1

This invention relates to liquid distributing ferrules for use with vertical tubular heat exchanging apparatus such as condensers, brine coolers, water coolers and other types of heat exchangers.

This invention is particularly designed for heat exchangers of the type herein illustrated, in which a shell is provided with upper and lower tube heads through which extend the open ends of a vertical tube bundle enclosed within said shell, and in which the upper tube head is the bottom of a box to which liquid is supplied, and from which it is distributed to the tubes. The shell contains the vapor to be condensed or the liquid to be cooled, as the case may be. In apparatus of this type it is important:

(*a*) That liquid should be equally distributed to each of the tubes;

(*b*) That the entire interior surface of the tubes be wetted with a continuous layer of uniform thickness of flowing liquid;

(*c*) That the level of the liquid in the liquid box be maintained uniform throughout.

For the purpose of accomplishing these results it is customary to provide distributing ferrules for the upper ends of the tubes, having inlets submerged in the body of liquid in said box.

The general object of the present invention is to provide a distributing ferrule which by virtue of its novel structure and design performs more efficiently than any of the known ferrules which have come within the sphere of applicant's experience.

Other objects of the invention will appear as the following description of two embodiments of the same proceeds.

In the accompanying drawings:

Figure 1 is a vertical section through a condenser, the intermediate portion being omitted, illustrating the position of the ferrule of the subject invention with respect to the appurtenant condenser structure;

Figure 2 is a front elevation of one form of ferrule;

Figure 3 is a vertical diametrical section at right angles to the view shown in Figure 2;

Figure 4 is a plan view;

Figure 5 is a front elevation of a modified form of ferrule;

Figure 6 is a side elevation.

Referring now to a detailed description of the figures, the shell 1 has an upper tube head 2 which extends beyond the periphery of the shell and has the upwardly disposed side walls 3 defining with the tube head 2 a water box on top of

2

the shell. Within the shell are the spaced vertical water tubes 4 which open adjacent the upper face of the tube head, within the water box. Each of the tubes is provided at its open end with one of the distributing ferrules 5.

In the interest of maintaining the body of water in the water box substantially static, the group of ferrules is surrounded by a distributing ring 7 resting upon the tube head 2, preferably higher than any depth of water which will be maintained in the water box, and preferably having several circumferential series of perforations at different levels. Water is admitted to the water box outside of the ring 7, preferably at opposite points 8.

Any pronounced current in the body of water in the water box would favor the distribution of water to certain ferrules and militate against the desired equal distribution of water to all.

Referring now to Figures 2, 3 and 4, the ferrule 5 comprises a disk 9 adapted to rest gravitationally upon the upper end of the tube 4, having its lower side circumferentially rabbeted to provide a portion 10 of small diameter adapted to fit freely within the tube and prevent lateral displacement of the ferrule.

A nozzle 11 projects upwardly from the center of the disk having an axial vertical bore 12 therethrough. Said bore is coaxial with the lower portion 10 of the disk, and therefore, coaxial with the bore of the tube upon which the ferrule fits. The purpose of having the nozzle 11 project above the disk 9 is to elevate the inlet of the ferrule above the bottom of the water box to prevent sediment entering the ferrule, and the length of the bore 12 is kept short so that the weight of the column of water descending said bore will not draw a depression in the level surface of the body of water in the water box above said bore. The mouth of the nozzle 11 lies in a horizontal plane so that water flows in equally from all sides to minimize turbulence, and for the same reason the external surface of said nozzle is convergently tapered toward its end, as indicated at 13, so that water flowing in from a region below the end of the nozzle will meet the transversely flowing water in an oblique direction. The nozzle has a relatively narrow neck 14 defining an overhanging shoulder 15 which serves as a finger grip in removing the ferrule. In this connection it is to be noted that the nozzle structure is symmetrical on all sides with respect to the axis of the nozzle and devoid of all projections which would tend to obstruct the uniform circumferential flow of water from all sides into the bore 12.

Beneath the disk 9 is a baffle 16, the upper surface of which descends symmetrically in all directions from a peak which is in the axis of the bore 12. This surface may be curvilinear as in Figures 3 and 4, or conical as in Figures 5 and 6. The diameter of the baffle 16 is so related to the dameter of the lower portion 10 of the disk 9 as to provide an annular space between said baffle and the tube within which the portion 10 fits, having an area greater than the cross-sectional area of the bore 12, so that there will be no backing up of water in the ferrule anterior to the baffle 16.

The baffle 16 is spaced from the disk 9 a sufficient distance to assure a break in the water column between the bore 12 and said baffle, to prove a definite shortness of the water column in said bore, for reasons above explained. The baffle is supported from the disk 9 by means of posts 17, which as shown, are diametrically opposite and joined to the baffle in areas which are remote both from the peak of the baffle and from its peripheral edge. Thus, the water from the bore 12 flowing symmetrically upon the unobstructed peak portion of the baffle is uniformly distributed upon all sides of the baffle. That which encounters the posts flows around the foot of each post on both sides and reunites at the outer edge of the foot of each post, forming a continuous annular layer of water flowing down the unobstructed peripheral margin of the baffle against the adjacent surrounding wall of the tube.

The design of ferrule shown in Figures 2, 3 and 4 is for larger sized tubes, that shown in Figures 5 and 6 for tubes of smaller size in which a single post 18 is adequate. Figures 5 and 6 show a ferrule 19 having a conical form of baffle, but alternatively the baffle may be curvilinearly convex, as in that form shown in Figures 2, 3 and 4. In other respects the above structural description applies equally to both forms.

It will be understood that in the same heat exchanger ferrules of identical construction will be employed with passages of the same diameter so as to maintain uniform conditions of discharge through all the tubes.

It is important that the level of water in the water box above the nozzles shall be maintained uniform throughout, since the rate of flow through each ferrule depends upon the head above it, and equal distribution through all of the ferrules is essential for optimum efficiency. Several factors may affect uniformity of level, which may be best understood by considering the old commercial form of ferrule which the ferrule of the present invention is designed to supersede.

This consists of a removable tubular ferrule open at the top, extending above the level of the water in the water box, and having a submerged inlet opening in one side. The water enters tangentially with a swirling movement through which all sides of the water tube are wetted, but the swirling creates turbulence and more or less shattering of the water. It is characteristic of a descending hollow column of water that it entrains air from the central space, producing some degree of vacuum in the central space. The vacuum tends to pull water through the ferrule. Under the conditions attending the swirling movement of the water in the old form of ferrule, the air entrainment is excessive, the pull on the water relatively great, and the turbulence cannot be controlled so as to be uniform in all the tubes, so that in the absence of an air relief, more water

will be discharged through one ferrule than through another, resulting in depression in the level of the water body in the water box above those ferrules producing the greater drain, setting up objectionable currents in said water body. The open top of the ferrule affords the necessary air relief, but requires the locating of the water inlet at one side of the ferrule. Therefore, in replacing the ferrules after removing them for cleaning the tubes, one may inadvertently place the water inlets of certain adjacent ferrules in juxtaposition, creating an aggregate discharge in certain localized areas in excess of the discharge in other localized areas where the water inlets may be more remotely spaced. This condition creates disturbances in the uniformity of the level of the surface of the water body.

In the subject invention, the fact that the water is applied smoothly and without any swirl or turbulence to all sides of the tube in a smooth layer of uniform thickness results in minimum air entrainment so that there is little or no vacuum produced in the tubes, and what vacuum there may be is the same for all tubes, obviating the necessity for an air vent in the ends of the ferrules. This makes it possible to locate the water inlets centrally of the ferrules, so that it makes no difference how the ferrules are relatively oriented in replacing them, the water outlets will be spaced uniform distances apart over the entire bottom of the water box. This design permits larger water lanes between the orifice inlet openings of the ferrules. These larger water lanes promote an even distribution of the water over the entire tube sheet surface.

Another factor of importance in maintaining the level of water in the water box uniform throughout, is that the depth of submergence of the ferrules determines the number of gallons of water passing over the condensers or heat exchanger in a unit of time. Tables have been worked out showing the number of gallons per unit for a given diameter of water inlet and various water heads above the ferrules. To determine a given rate of flow over the condenser, it is necessary only to refer to the table and to regulate the supply of water to the water box so as to maintain a level of the water body therein corresponding to the desired rate of flow.

By the device of the present invention it is possible to clean the tubes one at a time, without interrupting the operation of the apparatus, by lifting out one ferrule at a time and inserting the clean implement into the exposed tube.

While water has been referred to as the coolant in the above description, it will be understood that this is merely an example of any eligible liquid which may be similarly employed.

What I claim as my invention is:

1. Distributing ferrule for the water tubes of vertical tube heat exchangers, comprising a disk peripherally rabbeted to provide a flange adapted to seat on the tube end, and a portion of smaller diameter below said flange adapted to freely seat within the tube for centering the ferrule, a nozzle of less diameter than said disk projecting upwardly from the central portion of said disk coaxial therewith, having a lower cylindrical portion adjacent said disk, an intermediate cylindrical portion of slightly greater diameter than said lower portion so as to overhang said lower portion, and an upper upwardly convergent portion terminating in a plane perpendicular to the axis of said disk, said nozzle and disk having a coaxial bore of small uniform diameter extending

therethrough, a baffle beneath the lower end of said portion, spaced therefrom, having an upper liquid distributing surface descending uniformly on all sides from a peak in the axis of said bore, and having a coaxial circular periphery of smaller diameter than the lower portion of said disk, and a post supporting said baffle connected to said disk and to the upper side of said baffle at an intermediate point in its surface, leaving an area of said surface about its peak, and an area about its margin, unobstructed throughout the circumferential extent of said areas.

2. Distributing ferrule as claimed in claim 1, the upper surface of said baffle being convex.

3. Distributing ferrule as claimed in claim 1,

the liquid distributing surface of said baffle being conical.

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