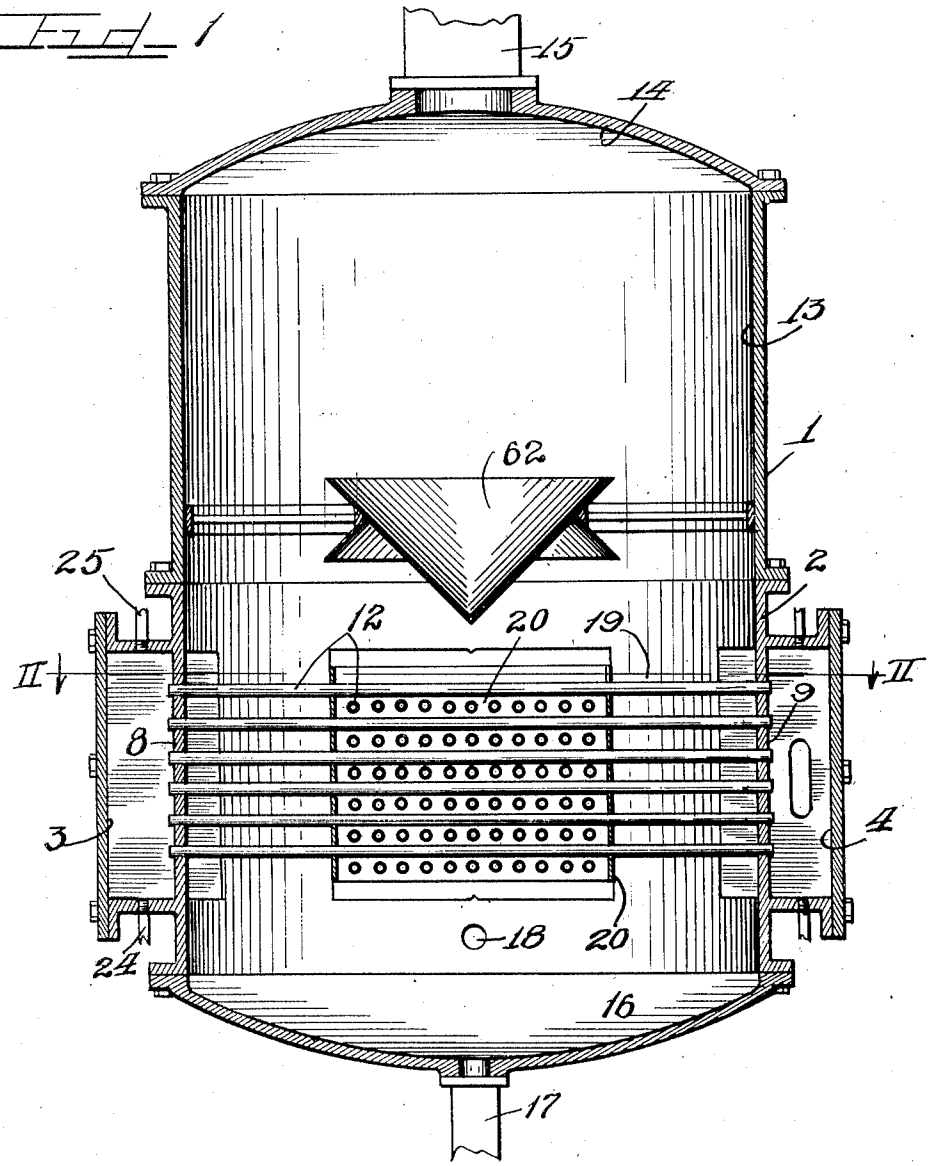
Feb. 23, 1932. P. B. SADTLER 1,846,067

EVAPORATOR

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Fig. 1



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Fig. 2

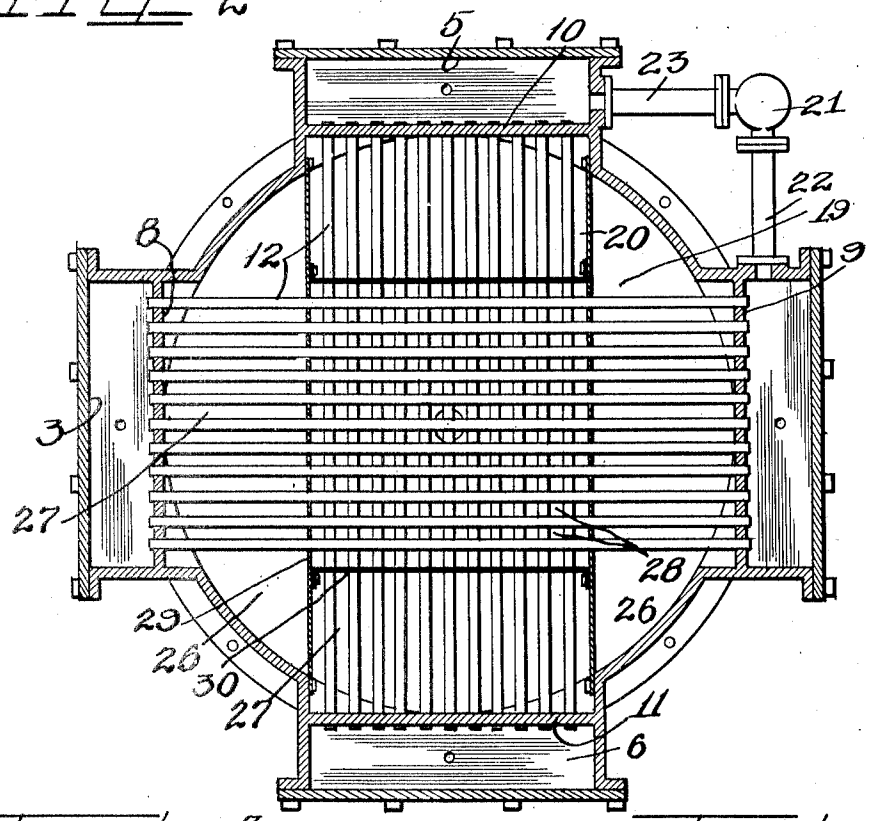


Fig. 3

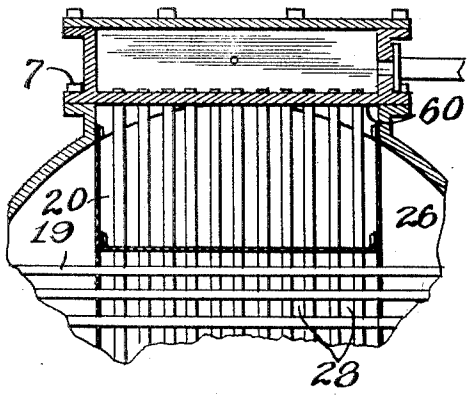
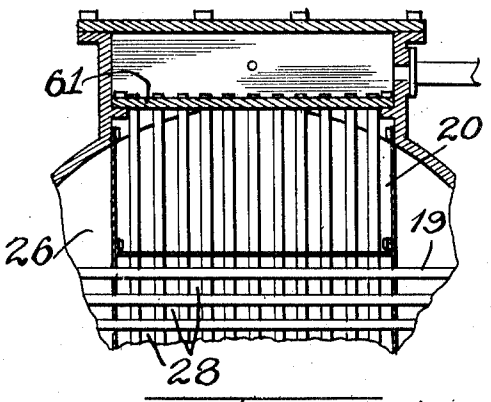


Fig. 4



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EVAPORATOR

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Fig. 5

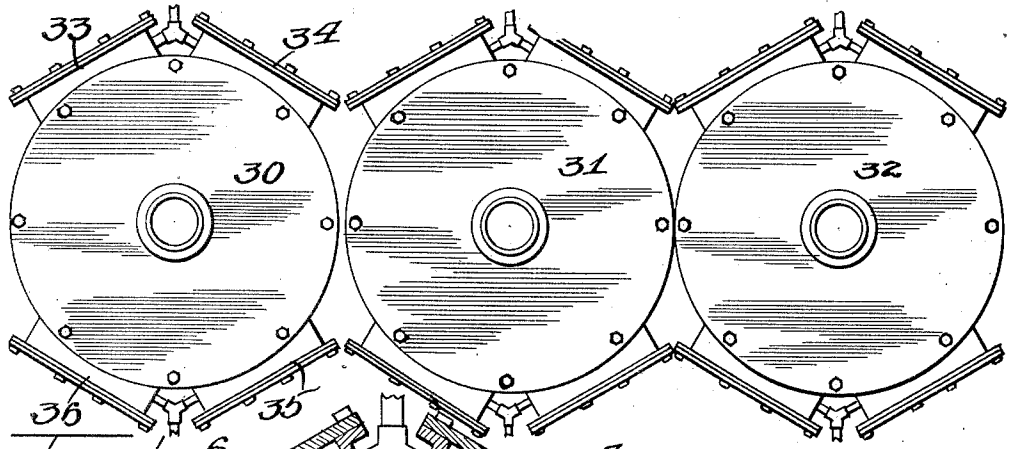


Fig. 6

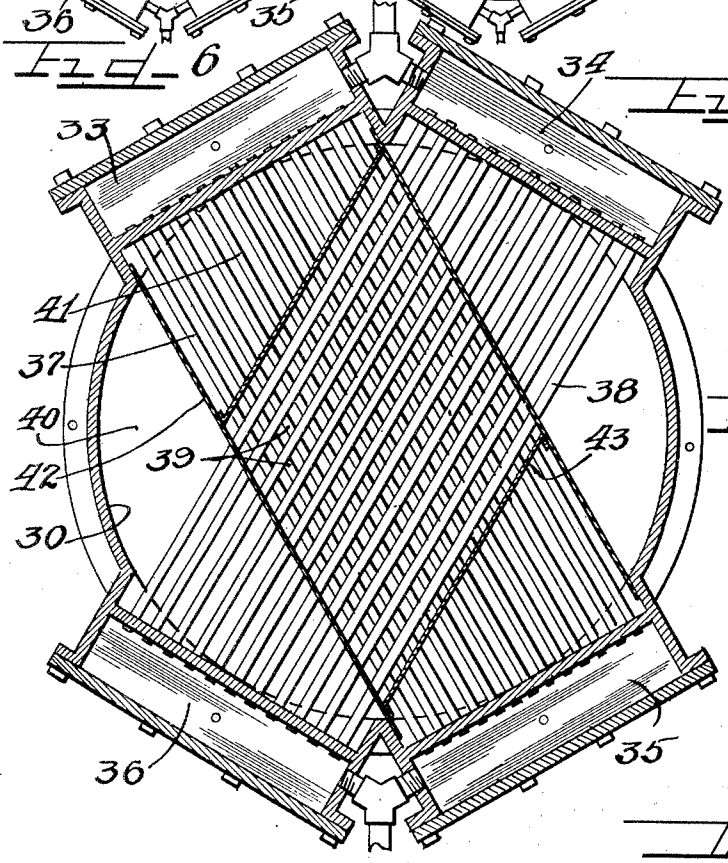


Fig. 7

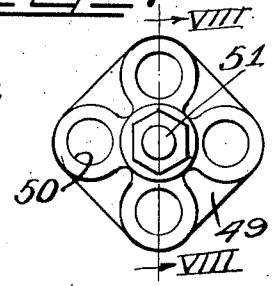
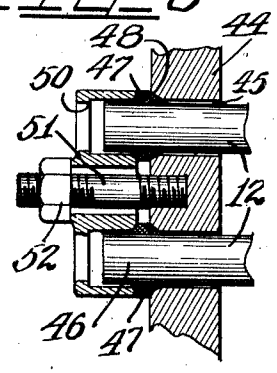


Fig. 8



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Patented Feb. 23, 1932 1,846,067

UNITED STATES PATENT OFFICE

PHILIP B. SADTLER, OF HARVEY, ILLINOIS, ASSIGNOR TO SWENSON EVAPORATOR COMPANY, OF HARVEY, ILLINOIS, A CORPORATION OF ILLINOIS

EVAPORATOR

Application filed February 1, 1929. Serial No. 336,736.

This invention relates to evaporators and more particularly to the type of evaporator known as the horizontal tube evaporator.

This type of evaporator, which has been known ever since steam heated evaporators were built, possesses many advantages, especially with respect to its cheapness of construction and ease of the tube renewal, but it has relatively low heat transfer coefficients. A form which has been widely used has a rectangular body with the tube banks covering the full width of the body. Horizontal tube evaporators have also been built with the body in the form of a vertical cylinder, the tube banks in such cases varying from the full width of the cylindrical portion to a width less than that of the cylindrical portion. The cylindrical construction has certain advantages as regards erection and maintenance of joints.

It is well known that the rate of heat transfer in evaporators is largely dependent upon the velocity of the circulating liquids. In the horizontal tube evaporator, the circulation of the liquid is caused by bubbles of steam liberated on the heating surface and rising through the mass of the liquid. If the cross section of the evaporator is entirely filled with tubes, the generation of steam bubbles being uniform, no definite circulation is set up. In actual practice, the generation of steam bubbles is likely to be more violent at the point where the steam enters and therefore the liquid usually circulates upwardly between the tubes at the steam entrance end and downwardly between the tubes at the steam exit end. In the case of evaporators having a body in the form of a vertical cylinder with the tube banks narrower than the diameter of the cylinder, zones are formed at the side of the evaporator containing no heating surfaces. The theory in such cases is that the liquid will circulate upwardly between the tubes and downwardly through the empty zones, but in practice this does not generally occur, and the circulation in such evaporators is similar to that described above for evaporators with a rectangular body.

In order to provide vigorous circulation of the liquid, it is necessary that the rate of steam evolution be highly concentrated in certain areas and that there be much less steam evolution, or none at all, in certain other areas. In those areas in which the steam evolution is most vigorous there will be an upward circulation of the liquid, and in those areas where steam evolution is less vigorous, there will be a downward circulation of the liquid. In addition to this there should be provided fairly definite paths for the liquid circulation. If these paths are marked off by fairly definite boundaries, and if the steam evolution is vigorous in that part of the path provided for upcoming liquid, circulation will be more vigorous and heat transfer rates will be greater.

It is therefore an object of my invention to provide an evaporator of increased capacity and having large heating surfaces per unit of floor space occupied, with well defined, concentrated heating zones for the upward circulation of the liquid to be evaporated and other well defined zones containing relatively little heating surface for the downward circulation of the liquid.

It is a further object of this invention to provide an evaporator having a low cost per unit of heating surface.

It is a further important object of this invention to provide a type of horizontal tube evaporator wherein two sets, or banks of tubes are employed, arranged at such an angle with respect to each other that the tubes are readily removable even where a plurality of evaporator units are placed in closely adjacent position with respect to each other.

Other and further important objects of this invention will be apparent from the disclosures in the specification and the accompanying drawings.

This invention (in a preferred form) is illustrated in the drawings and hereinafter more fully described.

On the drawings:

Figure 1 is a vertical sectional view of an evaporator embodying the principles of my invention, with parts in elevation;

Figure 2 is a sectional view taken substantially on line II—II of Fig. 1;

Figure 3 is a fragmentary sectional view

showing a modified manner of securing the tubes in the tube sheets;

Figure 4 is a fragmentary sectional view of a second modified manner of securing the tubes in the tube sheets;

Figure 5 is a top plan view of a modified form of my evaporator arranged in a plurality of evaporating units;

Figure 6 is an enlarged horizontal sectional view of one of the evaporating units shown in Figure 5;

Figure 7 is a detail view of a plate for securing the tubes, with parts in elevation; and

Figure 8 is a fragmentary sectional view taken substantially on line VIII—VIII of Fig. 7, with parts in elevation.

The reference numeral 1 indicates an evaporator embodying the principles of my invention. Said evaporator 1 is preferably formed in two or more sections, with a lower body casting 2 provided with four steam chambers, 3, 4, 5 and 6.

Said steam chambers may be cast integral with the body casting 2 or cast separately and bolted to the body section by means of bolts 7 as shown in Fig. 3.

In the steam chambers, there are tube sheets 8, 9, 10 and 11, respectively, provided with apertures for the insertion of heating tubes 12. These tube sheets may be cast integrally with the body casting 2, as shown in Figures 1 and 2, or they may be cast integral with the steam chests, as the tube sheet 60 shown in Figure 3; or they may be entirely separate from either and be secured to the back of the steam chest by any convenient means as in the case of tube sheet 61 shown in Fig. 4.

The evaporator 1 includes in addition to the body casting 2, one or more body rings 13, a cover 14 having a vapor outlet 15 therein, and a bottom 16 having a liquid withdrawal connection 17. The liquid to be evaporated may be fed into the evaporator at any convenient point, such as through the opening 18 below the tubes 12.

Between the tube sheets 8 and 9 are positioned a plurality of tubes 12 with their ends secured in said tube sheets 8 and 9, respectively, to form one set, or bank 19. A second set, or bank 20 extends between the sheet tubes 10 and 11 with their respective ends secured therein. Ordinarily, the steam banks and their tube sheets will be so placed that the tube chests 19 and 20 are at right angles to each other, as shown in Figures 1 to 4 inclusively, but that the angle may be less than a right angle is illustrated by Figs. 5 and 6. The number of rows of tubes in each set 19 and 20, respectively, is a matter of calculation for each individual case and is determined by methods familiar to those skilled in the art of evaporator design.

Steam, or other vapor used for heating, is supplied through a pipe 21 having a branch pipe 22 connected to the steam chest 4 and a second branch pipe 23 connected to the steam chest 5. Accordingly, steam enters all of the tubes in the sets 19 and 20 through the respective steam chests 4 and 5. Condensed vapor and non-condensed gases are removed through pipes 24 and 25 connected to the various steam chests.

In accordance with the principles of my invention, the width of each of the sets of tubes 19 and 20 is less than the diameter of the evaporator body, so that spaces 26 are formed between the evaporator body wall and the outer vertical rows of tubes 12 in which there are no tubes at all. This arrangement also leaves portions 27 wherein the tubes extend in a single direction only. The remaining central portion is substantially filled with intersecting rows of tubes forming a large number of vertical passages 28, around which the heating surface is highly concentrated and which form fairly definite paths for ascending columns of liquid.

The spaces 26 and 27, which are free or relatively free of heating tubes, form zones in which the evolution of steam is less violent and therefore serve as passages for accommodating downwardly moving currents of liquids.

In this way, the requirements for vigorous circulation in evaporators of the horizontal tube type are fulfilled and because of this vigorous circulation, higher heat transfer coefficients are obtained than in previously known types of horizontal tube evaporators.

Where for purposes of design, it becomes necessary to use relatively long, small diameter tubes, a support for these tubes at intermediate points is required. Tube supporting plates 29 and 30 serve this purpose and also define the central area in which the liquid to be evaporated is upwardly circulated.

Because of the violent ebullition and rapid circulation occasioned in the central area by foregoing construction, it is sometimes advisable to position a deflecting member 62 (Fig. 1) above said central area to prevent entrainment.

It will be understood that instead of arranging the intersecting tube banks 19 and 20 with alternate single rows, two rows of the tubes in the bank 20 may be interposed between two single rows of tubes in the bank 19, or any other desired arrangement may be effected. Preferably, however, alternate, single rows of intersecting tubes are employed and these tubes are arranged in as closely adjacent relation to each other as is practically possible.

In Figs. 5 and 6 there is shown an arrangement of evaporator units 30, 31 and 32 wherein the steam chests 33, 34, 35 and 36 of each unit are placed not at right angles to each other, but at angles, say of 60° and 30°. The purpose of this arrangement is to permit the various units to be spaced closely together

and yet permit of easy removal of the tubes. As best shown in Fig. 6 the tube banks 37 and 38 form in this case a diagonally shaped central zone 39 wherein the heating surfaces are closely concentrated and outer zones 40 and 41 containing no tubes and tubes running in a single direction, respectively. As before, tube supporting plates 42 and 43 are provided to more definitely confine the centralized heating zone.

In Figures 7 and 8, is illustrated the preferred manner of securing the tubes 12 in a tube sheet 44. Said tube sheet 44 is provided with apertures 45 of larger diameter than the outside diameter of the tubes 12, the ends of which extend through said tube sheet 44 as at 46. A suitable beveled packing 47 surrounds each of said tube ends 46 and is adapted to be pressed around said tube ends and into the apertures 45, which are countersunk as at 48 for that purpose. A plate 49 having apertures 50 for receiving the ends of four of the tubes 12 is adapted to be placed over said tube ends and secured to the tube sheet 44 by means of a central bolt and nut 51 and 52 respectively. In this position the clamping plate 49 engages the packing 47 and wedges it tightly in position.

In usual evaporator practice, the plate 49 is positioned with two of its edges horizontal and the dimensions between centers of the apertures 50 are such that the vertical distance between successive tubes or rows of tubes is slightly greater than the outside tube diameter. Consequently, my method of arranging two sets of intersecting tubes practically doubles the heating surface for the same space occupied by a single set of tubes such as normally used.

I am aware that many changes may be made and numerous details of construction may be varied through a wide range without departing from the principles of this invention, and I, therefore, do not purpose limiting the patent granted hereon otherwise than necessitated by the prior art.

I claim as my invention:

1. In a horizontal tube evaporator having a cylindrical body, two intersecting sets of tubes disposed substantially at right angles to each other within said body, the width of each set of tubes being less than the diameter of the body to form spaces adjacent the body wall free of tubes, spaces adjacent the body wall containing tubes running in only one direction and a central space filled with closely adjacent, criss-crossed tubes and tube supporting plates bounding said central space to define an area for the upward circulation of a liquid to be evaporated.

2. In a horizontal tube evaporator having a cylindrical body, two intersecting sets of horizontally disposed tubes within said body, each set comprising a plurality of closely spaced tubes arranged in vertically and horizontally alined rows with the horizontal rows of one set alternating with the horizontal rows of the other, each of said sets being of a width less than the diameter of the body to provide a central space substantially filled with closely arranged intersecting tubes and outer spaces relatively free of tubes, and baffle members bounding said central space to define an area for the upward circulation of a liquid to be evaporated.

3. In a horizontal tube evaporator intersecting sets of tubes, tube supporting plates bounding the crossed portions of said tubes to thereby form chambers in said evaporator to define the path of travel of the liquid to be evaporated.

4. In a horizontal tube evaporator intersecting sets of tubes, the width of said tube sets being substantially less than the width of the body so as to form a central space having closely adjacent criss-crossed tubes and other spaces having lesser members of tubes, and tube supporting plates forming bounding walls for said central space.

In testimony whereof I have hereunto subscribed my name at Chicago, Cook County, Illinois.

PHILIP B. SADTLER.