Aug. 20, 1935. W. H. CARRIER 2,012,183

SHELL AND TUBE EVAPORATOR

Filed March 9, 1934 2 Sheets-Sheet 1

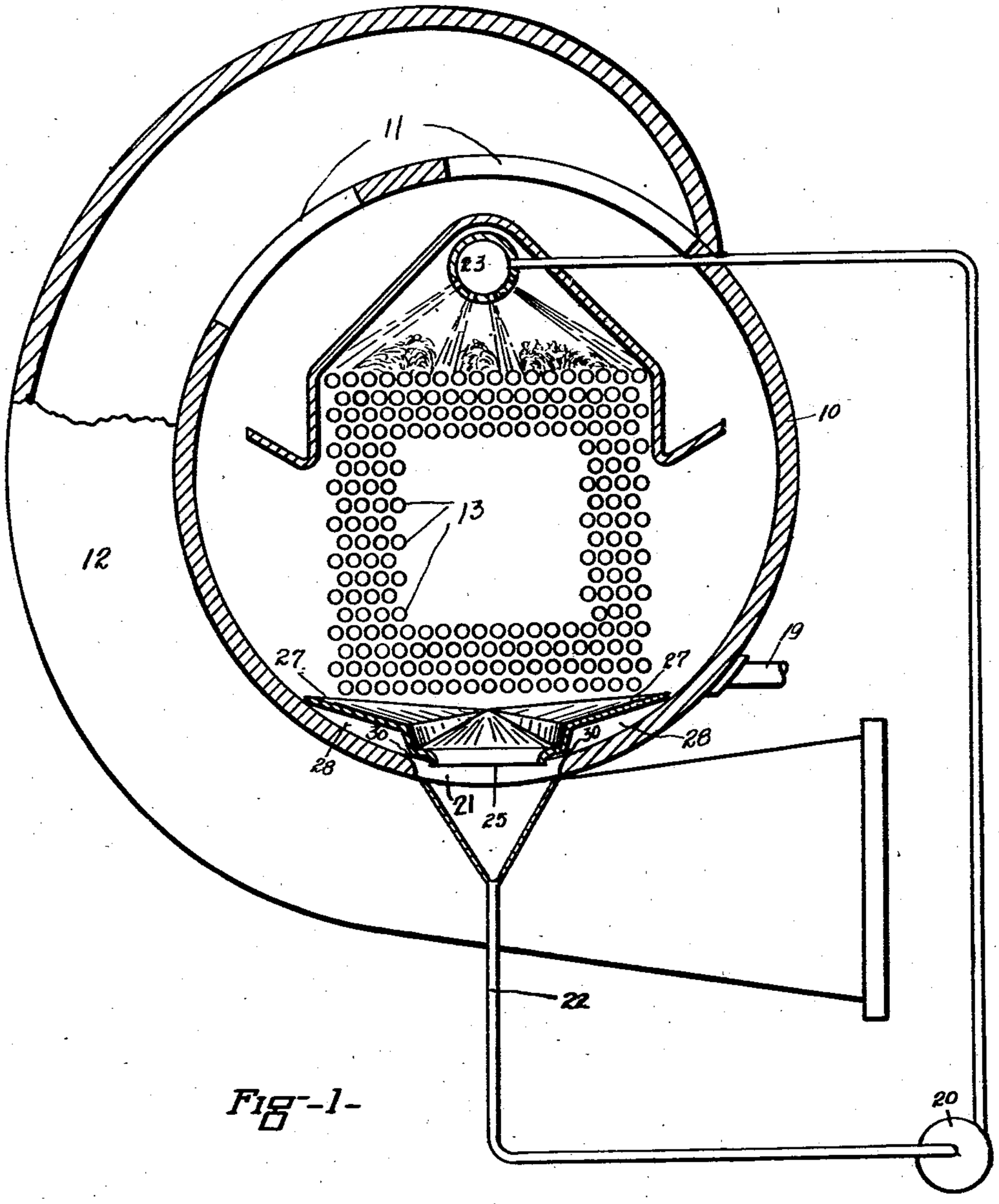

Fig.-1-

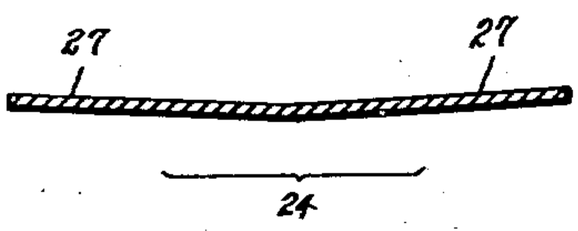

Fig.-4-

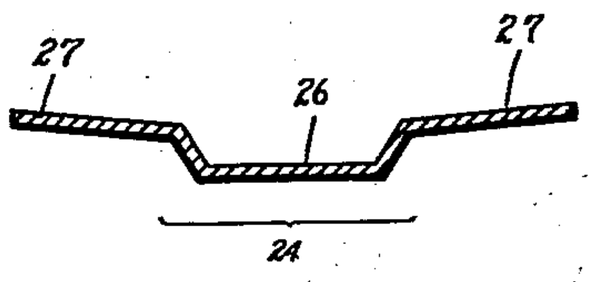

Fig.-5-

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SHELL AND TUBE EVAPORATOR

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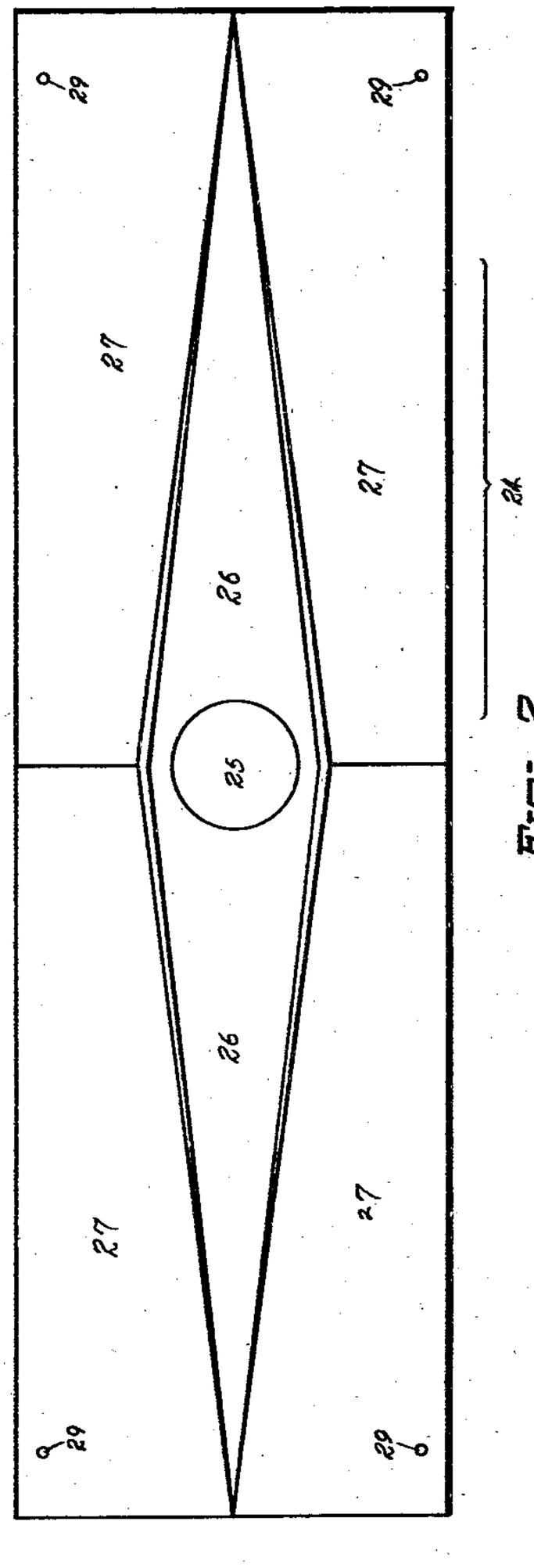

FIG-2-

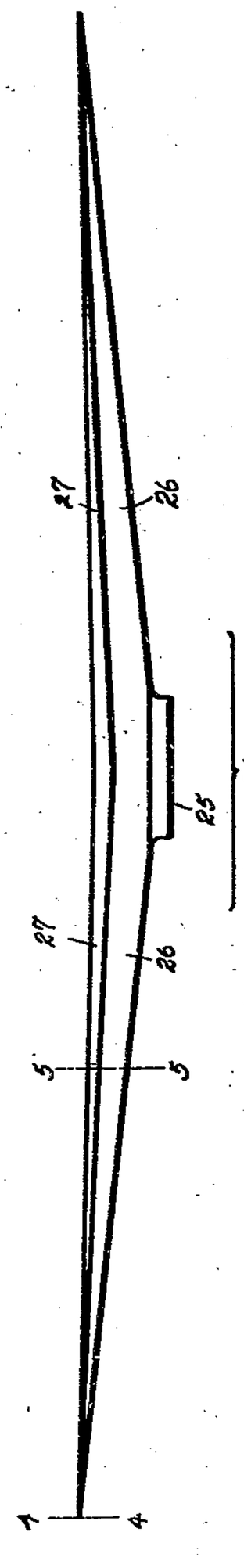

FIG-3-

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Patented Aug. 20, 1935 2,012,183

UNITED STATES PATENT OFFICE

2,012,183

SHELL AND TUBE EVAPORATOR

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Application March 9, 1934, Serial No. 714,767

7 Claims. (Cl. 62—126)

This invention relates to heat interchangers and more particularly to an improved form of shell and tube evaporator.

The general object of the invention is to provide a shell and tube evaporator, the shell of which may readily be constructed of welded steel and which will be smaller in size and generally less expensive than comparable present day evaporators. To this end, this invention may be combined with that of my copending application, Serial No. 714,768 filed March 9, 1934.

Another object of the invention is to provide an evaporator in which the refrigerant charge is considerably less than the refrigerant charge of present day evaporators of the same type and equal refrigerating capacity.

Still another object of the invention is to utilize the evaporator for storing the liquid refrigerant during periods when the evaporator is inoperative; and to prevent freezing of the lower tubes of the evaporator during the periods when the refrigerant is stored therein.

A further object of the invention is to prevent the accumulation of any substantial quantity of liquid refrigerant within the base of the evaporator shell during the periods when the evaporator is operative.

A feature of the invention resides in the provision in a shell and tube evaporator of a collecting pan beneath the tube net for directing towards a central outlet any refrigerant liquid which falls thereon.

In connection with the foregoing feature, another feature of the invention resides in providing an outlet in the pan which permits free and smooth flow from the pan into the outlet from the shell.

A further feature of the invention resides in forming a trough in the collecting pan, which trough has a maximum width and depth proximate the central outlet and a minimum width and depth at a point farthest from the outlet; and in so forming the edges of the pan that every portion thereof has a definite slope towards the central outlet.

Still another feature of the invention resides in mounting the collecting pan within the base of the shell in such a manner that the space beneath the pan may be used for refrigerant storage purposes.

The above objects and features, and various others making for efficiency and economy, will be more apparent from the following description to be read in connection with the accompanying drawings, in which:

Fig. 1 is an elevation, partly in section, showing the evaporator generally, and the positioning of the pan within the base of the shell;

Fig. 2 is a plan view of the pan;

Fig. 3 is an elevation of the pan; and

Figs. 4 and 5 are sections of infinitesimal length taken on the lines 4—4 and 5—5, respectively, of Fig. 3.

With reference to the drawings, similar designations referring to similar parts, numeral 10 designates a cylindrical shell having one or more vapor outlets 11 proximate the top thereof. The outlets 11, and scroll 12, provide communication between the shell and any desired point, for example, the inlet of a centrifugal compressor (not shown). A plurality of tubes 13, constituting a nest, or bundle, pass through the shell 10 and are held, at the opposite ends thereof in suitable tube sheets. Water, or any other medium to be cooled, is admitted to the tubes, and withdrawn therefrom, through suitable water boxes attached to the ends of shell 10.

Liquid refrigerant, from a refrigerant condenser, for example, is admitted to the shell 10 through supply pipe 19. Pump 20, illustrated diagrammatically, withdraws liquid from the base of shell 10, through outlet 21, and pipe 22; and discharges this liquid through one or more refrigerant distributing headers 23, positioned above the tube nest. The refrigerant is discharged from the headers in a plurality of streams, and upon striking the tubes is subdivided by impact into very fine particles, as illustrated. In this manner, a very complete distribution of liquid over the entire top of the tube nest is secured. The liquid flows by gravity from the first row of tubes, to the second, to the third, etc., thus covering each tube with a thin film of refrigerant. Any excess falls from the lowest row of tubes and is collected for recirculation by the pump 20. Refrigeration is, of course, secured in the usual manner by evaporating a portion of the refrigerant from the tube surfaces, the resulting vapor being removed from the shell through the outlets 11 and the scroll 12.

In order to maintain the desired circulation of liquid over the tubes, it is necessary to maintain a head of liquid in the stand pipe 22. With the usual cylindrical evaporator, this would entail maintaining a head of several inches of liquid in the base of the shell, in order that the refrigerant may flow towards the outlet 21. In other words, in such an evaporator, a quantity of liquid which has no function in the refrigerating proc-

ess must be supplied. Since the refrigerant is expensive and for other obvious reasons, this useless excess should be kept to a minimum. Applicant accomplishes this by providing a pan 24 beneath the tube nest. The pan is substantially constant in width throughout its length, but is so constructed that every part thereof is inclined toward an opening 25, which opening is directly above the outlet 21 in the base of the shell. As can be seen in the drawings, a trough 26 is formed along the longitudinal center line of the pan, which trough widens and deepens from a minimum at each end to a maximum at the opening 25. Conversely (Fig. 2) the upturned edges 27 have a maximum width and minimum slope towards the longitudinal center line at the ends thereof and a minimum width and maximum slope at a point opposite the outlet 25. Further (Fig. 3), the edges 27 slope from the ends thereof toward the opening 25. With this arrangement, it is evident that any liquid dropping from the tubes 13, or discharged into the shell through the inlet pipe 19, is immediately directed towards the opening 25, hence, the outlet 21, and stand pipe 22; and that the flow does not depend upon the maintenance of a head of liquid in the base of the shell.

Whenever the refrigerating machine is shut down, substantially the entire refrigerating charge collects at one point. Further, whenever the refrigerating load is very light, the pump 20 will be stopped, and hence, the liquid in the pump and circulating system, and the refrigerant returned from the condenser through pipe 19 will drain into the evaporator. While various expedients might be used, applicant prefers to store the liquid in the base of the evaporator shell. However, if all the liquid were collected in the pan 24, then the tube nest would have to be raised above the position shown in the drawings to prevent covering the lower tubes 13 and thus endangering freezing the liquid therein; and if the tube nest is raised, then a shell larger than the shell illustrated must be used. Applicant avoids these possibilities by mounting the pan in such a way that the refrigerant may collect beneath the pan in the spaces 28, as well as in the pan itself. In other words, the liquid falling on the pan is directed towards the central outlet 25, flows into and fills up the stand pipe 22, and then the liquid backs up through openings 30 (between pan 24 and shell 10) and fills the spaces beneath the pan to the same level as the liquid in the pan. If necessary, holes 29 may be provided at one or more points along the upper part of edges 27 for the purpose of venting the spaces 29. As can be seen, then, the pan 24 does not define the bottom of the shell, but merely provides a means for directing liquid towards the outlet 25. Since the pan itself is of relatively small volume, it is evident that it does not materially reduce the available storage space. Hence, substantially the entire base of the shell is available for this purpose.

While the particular form of pan illustrated is preferred, it is evident that any device which merely provides a means for directing the liquid falling thereon towards the outlet from the shell and which provides storage space therebeneath, may be used and is considered to be within the purview of this invention.

Since certain changes in carrying out the above process and in the constructions set forth, which embody the invention, may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. In an evaporator, a shell, a tube nest passing through said shell, a liquid outlet from said shell, means for discharging liquid from the base of said shell over said tube nest, and a pan beneath said tube nest for collecting the liquid falling therefrom and directing said liquid toward said liquid outlet.

2. In an evaporator, a shell, a tube nest passing through the shell, a liquid outlet from the shell, and a pan beneath said tube nest, said pan having an opening therein located above the outlet from the shell, said pan being formed to direct liquid falling thereon toward said opening, said pan being so mounted in the base of said shell as to provide liquid storage space therebeneath.

3. In an evaporator, a shell, a tube nest passing through the shell, a liquid outlet from the base of the shell, means for discharging liquid over the tube nest, and a collecting pan beneath said tube nest, said pan having a liquid outlet therein smaller than and located above the outlet from the shell, said pan being so mounted in the shell as to provide liquid storage space therebeneath.

4. In an evaporator, a shell, a tube nest passing through the shell, means for discharging liquid over said tube nest, a liquid outlet in the base of said shell, and a pan beneath said tube nest, said pan having an opening therefrom located above the outlet from the shell, said pan being so formed that every part thereof slops toward said opening.

5. In an evaporator, a shell, a tube nest passing through the shell, means for admitting liquid into said shell, a liquid outlet from said shell, and a pan located beneath said tube nest for directing liquid towards said outlet by gravity, said pan being so mounted in said shell as to provide liquid storage space therebeneath.

6. In an evaporator, a shell, a tube nest passing through said shell, means for admitting liquid into said shell, a liquid outlet from said shell, a pan beneath said tube nest for directing liquid falling thereon towards the outlet from said shell, said pan being so mounted in said shell as to provide liquid storage space therebeneath, and means for venting said liquid storage space.

7. In an evaporator, a cylindrical shell, a liquid outlet from the base of said shell, a tube nest passing through said shell, means for discharging liquid over said tube nest, and a pan in the base of said shell beneath said tube nest, said pan having a trough formed therein for directing liquid towards said liquid outlet, the edges of said pan being upturned for directing liquid into said trough.

WILLIS H. CARRIER.