Oct. 7, 1958

M. W. GARLAND

2,854,828

FREE FLOW EVAPORATOR

Filed April 2, 1956

FIG. 1

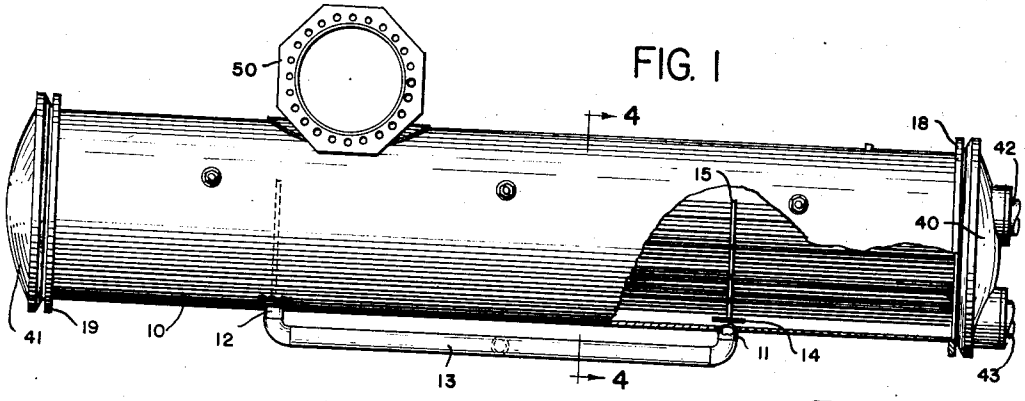


FIG. 2

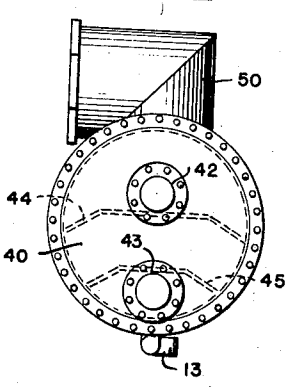


FIG. 4

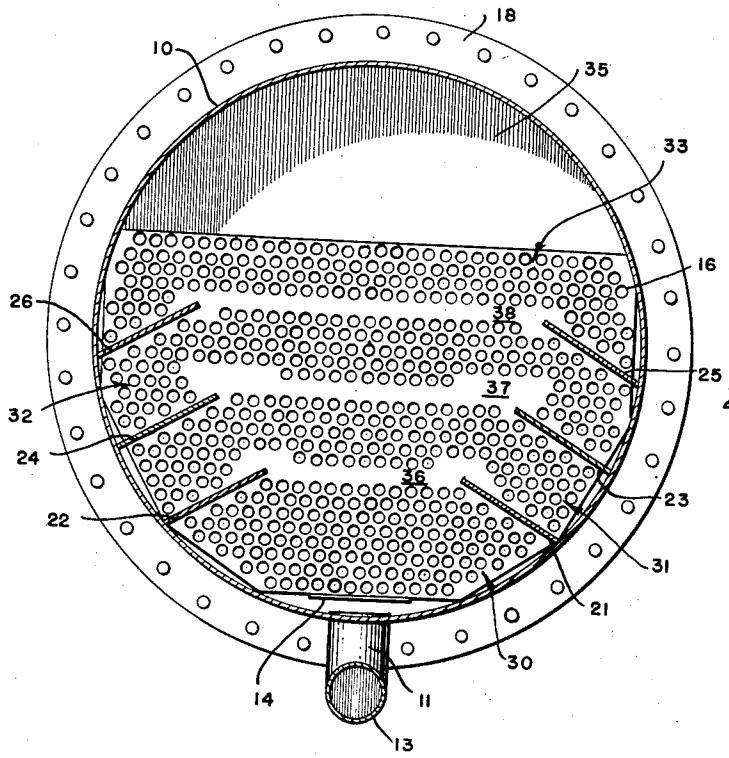
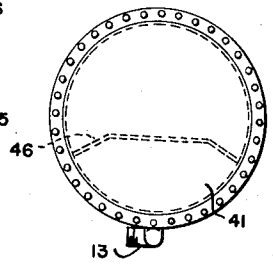


FIG. 3



INVENTOR
M.W. GARLAND

BY Agatadonee.
ATTORNEY

United States Patent Office 2,854,828 Patented Oct. 7, 1958

2,854,828

FREE FLOW EVAPORATOR

Milton W. Garland, Waynesboro, Pa., assignor to Frick Company, Waynesboro, Pa., a firm

Application April 2, 1956, Serial No. 575,507

9 Claims. (Cl. 62—394)

This invention relates to refrigeration and more particularly to an evaporator designed especially for refrigerants which have very high vapor volumes in relation to the amount of refrigeration produced.

This is a continuation in part of my earlier application entitled "Refrigerating System With Staged Condensing and Free Refrigerant Flow Flooded Evaporator," Serial No. 353,075, now Patent No. 2,830,797.

In refrigeration systems using refrigerants such as F–11 and F–113 in which the vapor or gas volume per unit of refrigeration is very high as compared with other refrigerants, certain problems arise. It is desirable that the evaporator permit relatively free flow without unduly obstructing the passage of the refrigerant in order to avoid having a high pressure drop, and, at the same time, provide for intimate contact between the refrigerant and the heat exchange elements in order to achieve efficiency.

Various attempts have been made to solve these problems heretofore. These have usually included providing for submerging the heat exchange elements in the liquid refrigerant; however, such submersion has usually required the use of an auxiliary container or the like which has itself presented an obstruction to the free flow of the refrigerant especially in the vapor stage.

Accordingly, it is an object of the present invention to provide an evaporator which affords a substantial amount of tube submersion in order to improve heat transfer and which is designed to permit the free flow of refrigerant through the evaporator.

A further object is to provide an evaporator in which the refrigerant rises through a series of spaced tube groups, the spaces between the adjacent groups being so arranged and of such size as to facilitate vaporization and the flow of refrigerant in both gaseous and liquid state in a vertical and horizontal direction, liquid refrigerant receiving means being provided at the sides adjacent to the spaces in order that intimate contact between the refrigerant and tubes may occur.

These and other objects of the invention will become apparent from the following description taken in conjunction with the accompanying drawing in which:

Fig. 1 is a side elevation of a shell and tube evaporator, with a portion of the shell broken away, constructed in accordance with the present invention;

Fig. 2, an end view of the front head;

Fig. 3, an end view of the rear head with the outlet omitted; and

Fig. 4, an enlarged section on the line 4—4 of Fig. 1 showing the interior of the shell and illustrating the arrangement and grouping of the tubes and inclined baffles.

Briefly stated, the illustrated embodiment of the invention is a shell and tube water cooler in which a plurality of spaced pairs of baffles extend longitudinally within the shell, the individual baffles of each pair being attached at one of their sides on opposite sides of the shell and extending at an angle upwardly toward the center of the shell. The baffles of each pair are spaced

a substantial distance apart at their free edges and provide, with the adjacent portion of the shell to which they are connected, a pocket or recess for refrigerant so that the tubes passing therethrough may be submerged. Intermediate the free ends of each pair of baffles is a free space which separates the tubes into groups and permits free vaporization and spreading out of the refrigerant, as is especially desirable with high vapor volume refrigerants.

Referring to the drawings, the evaporator includes an outer cylindrical shell **10** adapted to be horizontally mounted and having spaced liquid refrigerant inlets **11** and **12** supplied through a line **13** from a receiver, not shown. The inlet **11** is spaced approximately 25% of the length of the shell from the front end and the inlet **12** approximately 25% of the length of the shell from the rear end.

Within the shell the inlets **11** and **12** discharge against the lower surface of horizontal baffle plates **14** from the upper portion of which transversely mounted vertical baffle plates **15** extend approximately two-thirds the height of the shell, the vertical baffle plates **15** also assisting in supporting the tubes.

Within the shell, tubes **16** are mounted between front and rear end plates **18** and **19**, respectively, the end plates enclosing the ends of the shell and engaging the tubes in the conventional manner.

Between the end plates in the shell, a plurality of pairs of longitudinally extending baffles **21**, **22**; **23**, **24**; and **25**, **26**; are mounted on opposite sides of the shell. The baffles are of approximately equal width, those illustrated being approximately one-fifth as wide as the diameter of the shell, although the width may vary according to the particular installation and the design factors involved. Similarly, although the unattached sides of the illustrated baffles are inclined at an angle of approximately 30° to the horizontal, this may vary under different conditions.

In the illustrated embodiment, the lowermost pair of baffles **21** and **22** are attached by one of their longitudinal sides at the same horizontal level on the opposite walls of the shell so that their unattached or free sides terminate approximately 25% of the shell's diameter from the bottom. The next pair of baffles, **23** and **24**, are mounted in the shell so that their attached sides are at a slightly higher level than the free sides of the baffles **21**, **22**. Similarly, the next pair of baffles, **25**, **26**, are mounted so that their attached sides are slightly higher than the highest portion of the baffles **23**, **24**, the unattached sides of the baffles **25** and **26** extending slightly above the horizontal axis of the shell in the illustrated example.

The tubes **16** are mounted in the shell with a first group **30** being mounted above the inlet baffle plates **14** and below the baffles **21** and **22**. Succeeding groups of tubes **31** and **32** are mounted within the shell substantially intermediate the baffles **23**, **24**, and **25**, **26**. A fourth set of tubes **33** is mounted above the baffles **25**, **26** and extends upwardly a short distance to leave a free area **35** of substantial size at the top of the shell.

The groups of tubes **30**, **31**, **32**, **33** are separated by free spaces **36**, **37** and **38**, respectively, these spaces corresponding not only in location to the division plates in the water head, which will be described later, but being larger than the space required for the division plates, and designed to permit the free passage of liquid over onto the baffles at the side and the free escape of vapor both vertically and horizontally. Although the size of the spaces may vary in accordance with design factors such as the refrigerant used, it will be understood that the spaces are larger than necessary to accommodate the water head division plates or baffles, and

that the result is to provide a somewhat greater area for horizontal flow within the tube bank than for vertical flow therein.

It will be observed that the free or unattached sides of the baffles **21—26** diverge outwardly from the bottom of the shell thus facilitating unrestricted flow of the refrigerant as it expands.

The evaporator shell has heads **40** and **41** at its front and rear portions, respectively, for controlling the flow of the medium cooled, such as water, through the tubes. Head **40** has an inlet **42** at its upper portion and an outlet **43** at its lower portion. Between the inlet and the outlet baffles or dividers **44** and **45** are provided in the front head **40** and a baffle **46** in the rear head **41**. The head baffles **44** and **45** extend across the head in substantial coincidence with the longitudinal baffles **25, 26** and **21, 22**, and the rear head baffle **46** extends across the head in substantial coincidence with the longitudinal baffles **23, 24**.

An outlet **50** is mounted at the top of the shell for drawing off the refrigerant vapors to a compressor or the like which is not illustrated.

In the operation of the evaporator, liquid refrigerant enters the inlets **12** and **13** and flows longitudinally of the shell on either side of the tube supporting baffles **15**. Liquid refrigerant rises upwardly in the shell substantially submerging the tubes in the tube group **30**, resulting in a mixture of liquid and vaporous refrigerant being evolved in the space **36** above the tube group **30**. In space **36** the vapor can spread out to the sides for easier flow and, at the same time, liquid reaching this level can flow without impediment outwardly over the baffles **21** and **22** so that a level of liquid may be maintained on the upper surfaces of the baffles **21, 22** and the adjacent occluded portions of the shell.

The tubes in the tube group **31** located at the sides of the shell pass through the liquid which is retained in the pocket or recess between the baffle and the shell so that these remain in flooded condition. Liquid and vapor also continue to rise upwardly through the central portion of the tube group **31** and upon reaching the space **37** above the tube group spread out in free flow and submerge the tubes in the group at the sides of the shell. The same action occurs to the refrigerant passing through the succeeding tube groups.

As a result of the characteristic free flow and intimate contact of the refrigerant with the tubes, it has been found unnecessary to provide an eliminator at the top of the shell as has usually been necessary heretofore.

With respect to the flow of heating medium or medium being cooled, it will be seen that the medium flows through the uppermost group of tubes initially and then through the next succeeding lower groups of tubes in order, so that true counterflow is provided.

Accordingly, it will be understood that the present invention includes an evaporator providing for a high degree of flooded contact and, at the same time, which permits free flow of the refrigerant in both liquid and gaseous phase in order that the pressure drop may remain low.

It will be obvious to those skilled in the art that various changes may be made in the invention without departing from the spirit and scope thereof and therefore the invention is not limited by that which is illustrated in the drawing and described in the specification, but only as indicated in the appended claims.

What is claimed is:

1. An evaporator comprising an elongated shell for horizontal use, front and rear end plates connected to the shell at its ends, a plurality of vertically spaced tube groups within the shell and connected to the end plates, inlet means at the bottom of the shell, baffle means extending transversely and vertically from adjacent to the bottom of the shell over the inlet means but terminating substantially below the top of the shell in order to promote distribution of refrigerant entering the inlet longitudinally of the shell but not to interfere with free circulation at the upper portion of the shell; an outlet at the upper portion of the shell; a plurality of pairs of vertically spaced longitudinally extending baffles, the baffles of each pair being attached at one of their sides to the shell at approximately the same level and inclined upwardly at approximately the same angle, the lowermost pair of baffles being connected to the shell slightly above its bottom and the uppermost pair being connected to the shell at approximately midway between its lowermost and its uppermost extremities, the baffles of each pair having their unattached sides spaced substantially from each other and from the opposite side of the shell; intermediate tube groups being mounted substantially between the adjacent pairs of baffles with the spaces between the tube groups corresponding to the spaces intermediate the unattached sides of the pairs of baffles, there being a lowermost tube group beneath the lowermost pair of baffles and an uppermost tube group above the uppermost pair of baffles; whereby liquid refrigerant entering the inlet may rise vertically through the tubes and have free space for expansion and liquid movement in the spaces, and whereby liquid refrigerant may be retained on the upper surface of the baffles and in contact with the tubes adjacent thereto; and front and rear head baffles for directing medium to be cooled in a series of passes through the tubes.

2. An evaporator comprising a shell for substantially horizontal use having refrigerant inlet means at its lower portion and refrigerant outlet means at its upper portion, tube means extending through the shell, baffle means extending longitudinally of the shell and having a side attached to a side of the shell and being inclined upwardly in order to provide with the adjacent portion of the shell a recess for holding liquid refrigerant at the height of the baffle means without recirculation to refrigerant at a lower level, the opposite side of said baffle means being spaced from the opposite wall of said shell to provide a passageway for liquid and gaseous refrigerant, a portion of said tube means extending through said recess whereby liquid refrigerant in said recess is brought into direct contact with said portion of said tube means.

3. The structure of claim 2, said baffle means comprising a plurality of pairs of vertically spaced baffles, the baffles of each pair extending from the shell at approximately the same level and at approximately the same angle.

4. The structure of claim 3, said baffles each being of substantially the same width, the lowermost pair of baffles extending from the shell slightly above the bottom thereof and the uppermost pair extending from the shell at approximately midway between the bottom and the top thereof, the inward edge portions of the baffles from the bottom upwardly providing a diverging pathway for refrigerant.

5. The structure of claim 4, said tube means comprising a plurality of vertically spaced tube groups, a group being located substantially intermediate each adjacent pair of baffles and extending across the shell therefrom, a tube group beneath the lowermost pair of baffles and another tube group above the uppermost pair of baffles, the tube groups being separated by spaces intermediate the inner edges of each pair of baffles.

6. The structure of claim 5 in which there are three pairs of baffles and each baffle extends at an angle of approximately 30° to the horizontal.

7. The structure of claim 2, the refrigerant inlet means comprising a plurality of longitudinally spaced openings in the bottom of the shell, a horizontal baffle plate mounted over each inlet in proximity thereto, and a vertical transverse baffle plate extending upwardly from each horizontal baffle plate and having its upper edge spaced substantially from the top of the shell, for sup-

porting the tubes and promoting longitudinal distribution of the incoming refrigerant within the shell.

8. The structure of claim 5, the shell having front and rear heads at its ends, and dividers in the heads overlying approximately the same positions as the pairs of baffles and the spaces therebetween whereby flow of medium to be cooled through the tubes may be provided through the tube groups beginning with the uppermost and progressing downwardly seriatim.

9. The structure of claim 8, the said spaces being substantially larger than is required for the attachment of

the dividers within the front and rear heads in order to permit free flow of liquid and gaseous refrigerant through the tube groups.

References Cited in the file of this patent

UNITED STATES PATENTS

1,937,802	Baer	Dec. 5, 1933
2,247,107	Waterfill	June 24, 1941
2,384,413	Zwickl	Sept. 4, 1945