

July 26, 1932.

J. G. KING

1,868,907

REFRIGERATING APPARATUS

Filed Oct. 31, 1928.

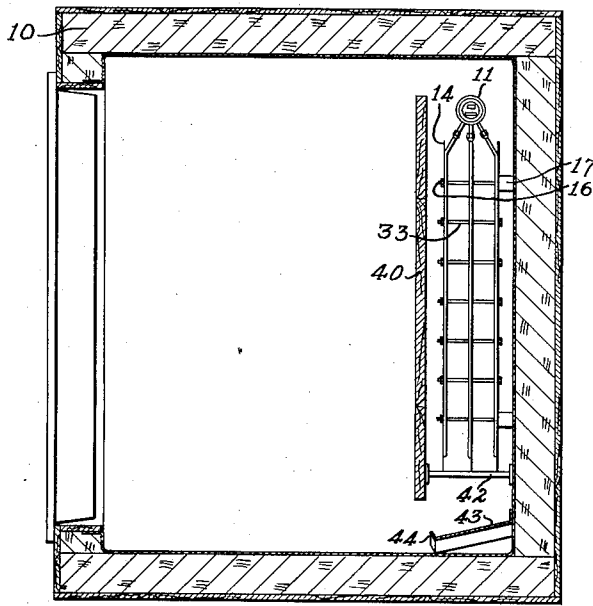


Fig. 1

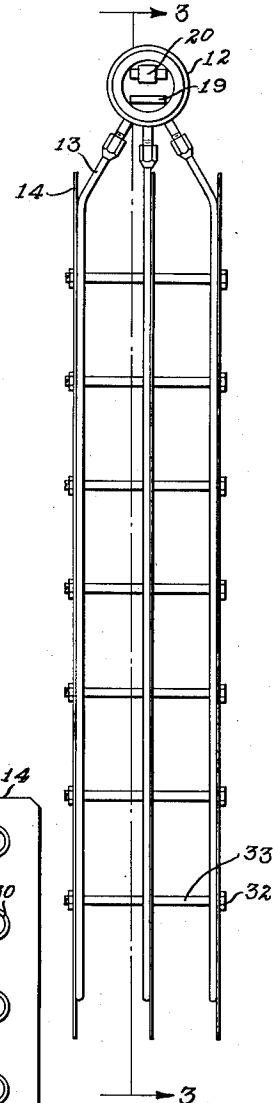


Fig. 2

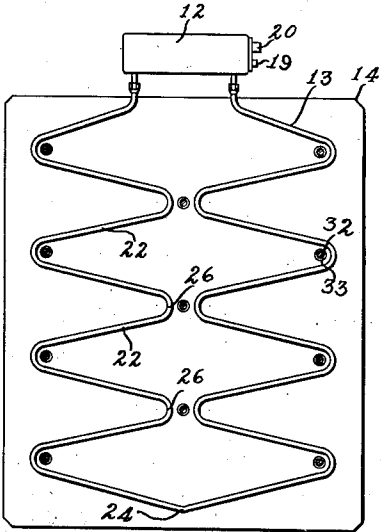


Fig. 3

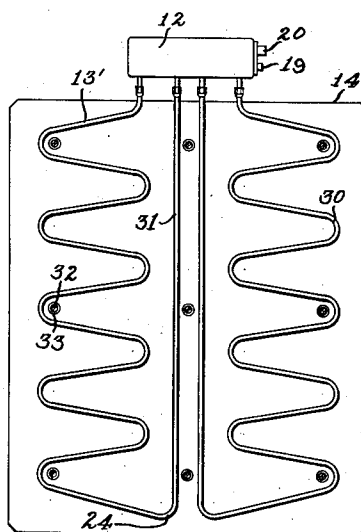


Fig. 4

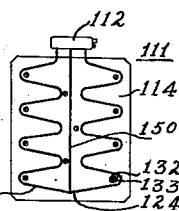


Fig. 5

Inventor
Jesse J. King,

By Spencer, Hardman & Zehr
Attorneys

UNITED STATES PATENT OFFICE

JESSE G. KING, OF DAYTON, OHIO, ASSIGNOR TO FRIGIDAIRE CORPORATION, OF DAYTON, OHIO, A CORPORATION OF DELAWARE

REFRIGERATING APPARATUS

Application filed October 31, 1928. Serial No. 316,274.

This invention relates to refrigerating apparatus and particularly to an improved form of refrigerating element or evaporator.

One of the objects of the invention is to provide a refrigerating element of the flooded type which has a very large heat exchange surface and yet has a relatively small number of evaporating chambers.

Another of the objects of the invention is to reduce the number of joints heretofore necessary in evaporators of large capacity.

Another object of the invention is to so arrange the refrigerant passages in a refrigerating element of the character mentioned so as to promote the circulation of refrigerant and escape of oil deposited in the evaporating chambers.

Still another object is to provide an improved arrangement of refrigerant conduits secured to fins or plates.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred form of the present invention is clearly shown.

In the drawing:

Fig. 1 is a vertical section of a refrigerating cabinet showing my improved refrigerating element in end elevation;

Fig. 2 is an enlarged end elevation of the refrigerating element;

Fig. 3 is a section on the line 3—3 of Fig. 2;

Fig. 4 is a diagrammatic view, on a reduced scale, of a modified form; and

Fig. 5 is a similar sectional view of a modified construction.

It has previously been proposed to construct evaporators having a header forming a reservoir for liquid refrigerant and a number of ducts or loops of conduit depending from the header and attached to fins or plates, usually by soldering. Where it is desired to construct an evaporator of large capacity there are several objections to this type of evaporator as heretofore known. If a tube is attached to a fin to increase its heat exchange surface there is a limited area of the fin over which heat will be conducted to the

tube at a sufficiently rapid rate to provide satisfactory refrigeration. Consequently heretofore when it was desired to make a refrigerating element of large refrigerating surface, either a large number of small fins were used or if large fins were used, a large number of tubes were secured to the fins relatively close together. Either type of construction necessitates a large number of joints between tubing and the header. Joints are undesirable first because they are expensive to make and second because they form points of weakness in the evaporator which are apt to develop leaks from one cause or another.

One of the features of the present invention is the provision of an evaporator of great heat exchange surface having a small number of joints.

Referring to the drawing 10 designates a refrigerating compartment or cabinet cooled by a refrigerating element generally denoted by 11. The refrigerating element includes a header 12 forming a reservoir for liquid refrigerant and a number of loops of tubing 13 for circulating refrigerant, each loop being formed in a plane and soldered throughout its length to a plate or fin 14. Each plate is preferably of such size as to occupy substantially an entire side or back wall of the cabinet. The refrigerating element may be conveniently supported from this side wall of the cabinet by bolts 16 and spacers 17.

Liquid refrigerant is admitted to the header by an inlet connection 19 and maintained at a constant level therein by means of any known float valve, for example that shown in the patent to Osborn 1,556,708. Evaporated refrigerant is withdrawn from the header through an outlet connection 20 above the liquid level. The tubes 13 are secured to the header in any suitable manner, as by detachable pipe couplings, soldering, or otherwise. Each tube is connected at both ends to the header below the liquid level, preferably at the bottom, and so is kept flooded with liquid refrigerant.

Where refrigerant conduits are soldered to fins as above described it has been found that there is a limited area along the conduit throughout which the fin will transmit heat

to the conduit at a sufficiently rapid rate to be effective as a practical refrigerating surface. This distance depends upon the temperature difference to be maintained between the refrigerant in the conduit and the atmosphere to be refrigerated, as well as the thickness of the fin, but for a given set of conditions there is a fairly definite and determinable distance from the conduit beyond which the fin is ineffective, practically speaking, as a refrigerating surface. That is, while surfaces at a greater distance than this will of course absorb some heat and the fin will transfer some of this heat to the conduit, the resistance to such heat flow is so great that the amount of heat which reaches the refrigerant is negligible for practical refrigerating purposes. The distance from the refrigerant conduit, through which the fin is a practical refrigerating surface, may be called the refrigerating range of the conduit. As a rough indication of this range in ordinary practice, it may be said that when refrigerant is being evaporated in the conduit the portion of the fin within the refrigerating range will become coated with frost. It will thus be seen that the factor which limits the refrigerating power of a fin of this sort in given circumstances is the distance from any given portion of the fin to the refrigerating agent and not the amount of refrigeration which can be supplied at some concentrated point such as the refrigerant conduit. The maximum permissible distance has been determined by experiment by attaching a conduit to a plate or fin in the manner indicated and evaporating the refrigerant in the conduit.

The coils 13 are arranged in serpentine fashion from top to bottom of the fins and so distributed that no point of the fin is farther away from some point of the conduit than the frosting or refrigerating range of the conduit. Each tube 13 may consist of a pair of serpentine coils arranged as in Fig. 3. Each serpentine coil, and in fact the complete loop 13 is entirely devoid of both horizontal passages and reverse bends in a vertical direction, that is each serpentine portion consists entirely of inclined passages 22 all of which slope upward from the lowest point 24 of the coil to the header. This provides a refrigerant path which throughout its entire length slopes and thus facilitates the escape of evaporated gaseous refrigerant, as well as oil which may be carried into the tubes in solution, and there deposited by the evaporation of the refrigerant. I have found that where a serpentine tube of this character includes horizontal passages of any appreciable length, oil and gaseous refrigerant may be retarded or trapped in such passages and offer sufficient resistance to the evaporation and removal of refrigerant as to materially reduce the refrigerating capacity of the evaporator. The pitch or slope of the inclined

portions 22 is the minimum which will permit the rapid escape of gas and oil, in order that the loops may be placed as close together as possible. That is, the points 24 and 26 must be placed no farther apart than twice the refrigerating range of the tube, and at this distance apart, the length of the passages 22 can be increased until the minimum slope is reached. This condition determines the maximum size of fin which can be refrigerated by a single tube.

Where the vertical height of the fin and coil is very large, I find that the speed of circulation of refrigerant in it, and consequently the refrigerating capacity of a given evaporator, may be materially increased by providing a straight vertical passage between the lower end of the serpentine coil and the header. Such arrangement could be effected by connecting a straight tube between the point 24 and the header. I prefer that the tubing forming the coil shall have no joints within the area of the fin because joints make the coil difficult to attach to the fin and are objectionable for other reasons. Consequently I prefer to form the coils as shown in Fig. 4 in which two coils 13' are attached to each fin, and each coil includes a serpentine portion 30 and a straight portion 31. In this construction the entire length of the coil is devoid of joints.

The plates 14 are held rigidly together in spaced relation by means of bolts 32 and spacers or collars 33. This forms a rugged structure consisting of a plurality of refrigerating plates spaced apart to provide air circulating flues between them. The distance apart of the plates is such that when the plates have become coated with frost in the ordinary practice there will be sufficient space between the frosted plates to provide ample air circulation.

It will be noted that each coil is always flooded with liquid refrigerant and that all the coils are connected to the header in parallel. This arrangement keeps the temperature along each conduit uniform, and the temperature of each conduit the same. By this means the entire surface of each fin is an effective refrigerating surface of substantially the same temperature.

The bolts 16 may be similar to the bolts 32 with their spacers 33. That is, the required number of bolts 16, which are similar to, but longer than bolts 32, may be substituted for a corresponding number of bolts 32. These bolts 16 may have spacers 33 placed on them between the plates or fins 14 and may have spacers 17 placed between the supporting wall and the adjacent plate or fin.

A baffle may be placed adjacent the refrigerating element 11, if desired. A suitable type of baffle is designated at 40. This baffle may be made of nonconducting material if desired, such as wood. It may be supported

at the ends from the side walls of the compartment 10 or may be supported from the ceiling or floor thereof. Bolts 42 may be placed between the baffle 40 and the wall of the compartment, on which bolts the element 11 may be supported.

A drain pan 43 may be placed underneath the element 11 to receive the products of condensation or of the defrosting operations. It may be provided with a lip 44 in order to provide a channel.

In Fig. 4 a slightly modified form is shown diagrammatically. A cooling element 111 may be provided with one or more fins or plates 114 held together by bolts 132 and spacers 133 similar to those used in the other modifications. A header 112 may be provided with loops of tubing 113 similar to the tubing 13, 22, 26 of Fig. 3. At a point corresponding to point 24 of the said Fig. 3 an upwardly directed tube 150 may join the tubing 113 and the header 112 for substantially the same purpose as in Fig. 5 but with a joint at 124. The element 111 may be otherwise similar to the element disclosed in Figs. 1, 2 and 3.

It is apparent that there will be a temperature gradient of the fins, that is, the outer edges of the fins will be somewhat warmer than the central parts because the circulating air flowing over the central parts will be pre-cooled by the outwardly extending portions, also, the central portion is protected from the relatively warm air by the header 12. By placing the ducts 31 or 150 in the central parts of the fins, very little, if any vaporization takes place in these ducts and they thus provide down-flow ducts for feeding the serpentine. In this manner, there will be a prevalent flow or positive flow of refrigerant downwardly through ducts 31 or 150 and upwardly through the serpentine and this positive flow minimizes oil logging of the serpentine in that type of evaporator in which a quantity of oil is contained in the evaporator.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A refrigerating element for refrigerating apparatus comprising in combination a header forming a reservoir for liquid refrigerant and an evaporating element connected to the header, said evaporating element including a planar heat exchange plate, a serpentine coil of tubing connected to the header and secured in intimate thermal contact with said plate, said coil consisting entirely of inclined passages, the maximum distance apart of adjacent passages being not greater than twice the refrigerating range of said tubing.

2. A refrigerating element for refrigerating apparatus comprising in combination a header forming a reservoir for liquid refrigerant and an evaporating element depending from the header, said element including a heat exchange plate in longitudinal alignment with the header and a pair of coils of tubing connected to the header and attached in intimate contact with said plate, each coil including a straight portion extending vertically from said header substantially the entire length of said plate, and a serpentine portion connecting the lower end of said straight portion with the header, said serpentine portion being devoid of horizontal passages and projecting longitudinally beyond the header, the straight portion of said coils being adjacent each other.

3. A refrigerating element for refrigerating apparatus comprising in combination a header forming a reservoir for liquid refrigerant, a plurality of planar coils of tubing connected to the header and depending therefrom, each coil including a serpentine portion devoid of horizontal passages, a heat exchange plate thermally connected to each of the coils, tie means holding said plates together and spacing means holding said plates apart to form air circulating flues.

4. A refrigerating element for cooling air flowing thereover, said element including header means for liquid refrigerant, a plurality of vertically extending serpentine evaporator chambers having the outlets thereof connected with the header means and having the inlets thereof at the lower ends, fin means below the header thermally connected with said chambers, and down flow duct means connecting the inlets with the header means, said duct means being disposed so as to be thermally protected from relatively warm circulating air.

5. A refrigerating element for cooling circulating air flowing thereover, said element including header means for liquid refrigerant, a plurality of vertically extending tortuous evaporator chambers devoid of horizontal passages, said chambers having the outlets thereof connected with the header means and having the inlets thereof at the lower ends, fin means below the header thermally connected with the chambers, and down flow duct means connecting the inlets with the header means, said duct means being disposed so as to be thermally protected from relatively warm circulating air.

6. A refrigerating element for cooling circulating air flowing thereover, said element including header means for liquid refrigerant, plate type fin means below the header, a plurality of substantially planar serpentine evaporator chambers lying parallel with the fin means, said chambers being thermally connected with the fin means and having the outlets thereof connected with the header

means and having the inlets thereof at the lower ends, and down flow duct means connecting the inlets with the header means, said duct means being disposed so as to be thermally protected from relatively warm circulating air.

7. A refrigerating element for cooling circulating air flowing thereover, said element including header means for liquid refrigerant, a plurality of vertically extending serpentine evaporator chambers having the outlets thereof connected with the header means and having the inlets thereof at the lower ends, fin means below the header thermally connected with said chambers, and down flow ducts each connecting one of the inlets with the header means, said duct means being disposed so as to be thermally protected from relatively warm circulating air.

8. A refrigerating element for cooling circulating air flowing thereover, said element including header means for liquid refrigerant, a plurality of vertically extending tortuous evaporator chambers devoid of horizontal passages, said chambers having the outlets thereof connected with the header means and having the inlets thereof at the lower ends, fin means below the header thermally connected with the chambers, and down flow ducts each connecting one of the inlets with the header means, said duct means being disposed so as to be thermally protected from relatively warm circulating air.

9. A refrigerating element for cooling circulating air flowing thereover, said element including header means for liquid refrigerant, plate type fin means below the header, a plurality of substantially planar serpentine evaporator chambers lying parallel with the fin means, said chambers being thermally connected with the fin means and having the outlets thereof connected with the header means and having the inlets thereof at the lower ends, and down flow ducts each connecting one of the inlets with the header means, said ducts being disposed so as to be thermally protected from the relatively warm circulating air.

In testimony whereof I hereto affix my signature.

JESSE G. KING.

55

60

65