Aug. 8, 1950 R. S. GAUGLER 2,517,654

REFRIGERATING APPARATUS

Filed May 17, 1946 2 Sheets-Sheet 1

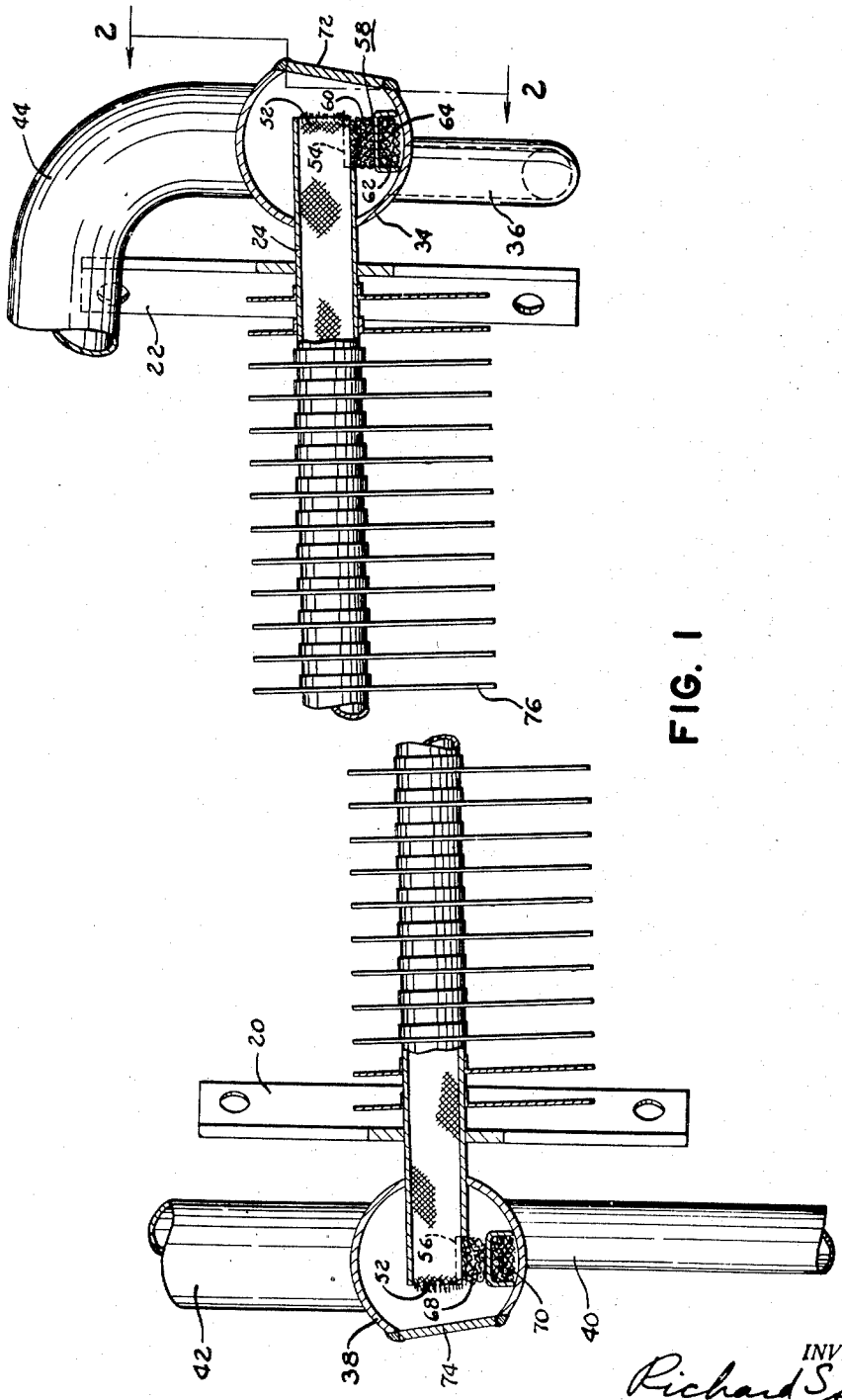


FIG. 1

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2 Sheets-Sheet 2

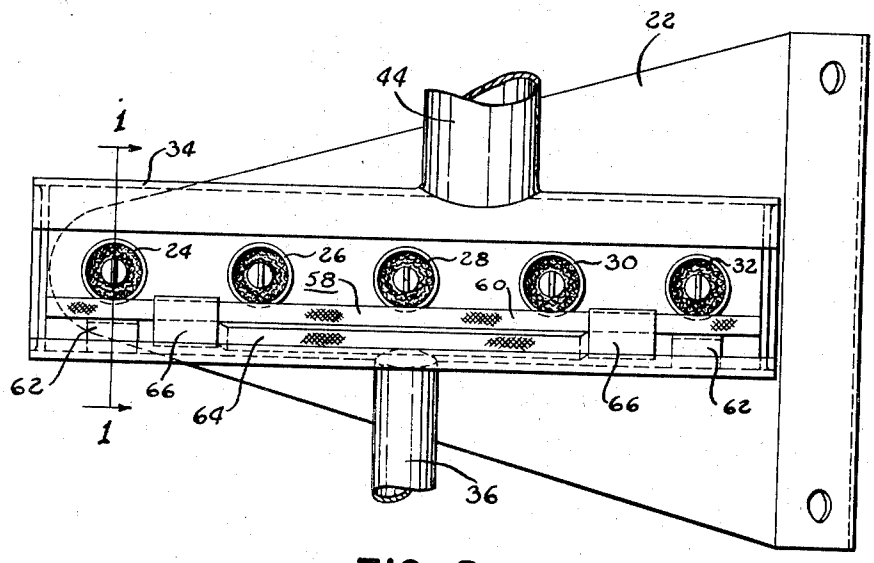


FIG. 2

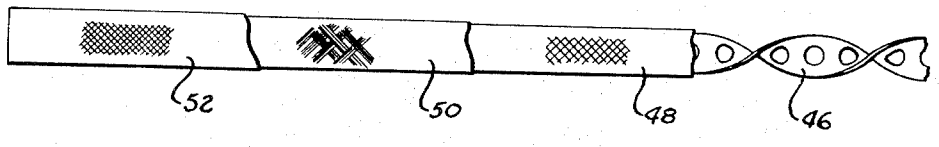


FIG. 3

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REFRIGERATING APPARATUS

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6 Claims. (Cl. 261—99)

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This invention relates to heat transfer apparatus such as, for example, may be used for evaporators and absorbers in absorption refrigerating systems.

The efficiency and effectiveness of heat transfer units depend largely upon the area of contact of the liquid with the heat transfer walls and the heat transmission between the heat transfer walls and the second fluid. Great difficulties in heat transfer are encountered in absorption refrigerating systems where the flooded type of heat transfer units are not used and where the liquid fills only a small portion of the evaporator and absorber. The efficiency of the absorber and evaporator depends largely upon the area of the liquid surface which is exposed to the circulating gas or vapor and the efficiency of the heat transmission through the walls between the liquid and the external air.

It is an object of my invention to provide an efficient heat transfer unit employing a plurality of small ducts having simple inexpensive means for producing turbulence and for holding wire gauze in firm direct contact with the entire inner wall surface for holding liquid in contact therewith by capillary action.

It is another object of my invention to provide an efficient heat transfer unit employing a plurality of small ducts having a plurality of wire gauze sleeves in firm contact with each other and with the walls of the ducts.

It is another object of my invention to provide a simple inexpensive heat transfer unit in which a thin exposed free liquid film of large area is exposed to gas and is also in direct contact with the heat transfer walls.

It is another object of my invention to provide a heat transfer unit having a plurality of parallel paths of liquid flow with a simple inexpensive form of capillary means for distributing the liquid flow to the parallel paths in substantially the proportions desired.

It is another object of my invention to provide a simple inexpensive heat transfer unit containing wire gauze sleeving in which excellent cooling is provided for dissipating heat from the wire gauze.

Briefly, these objects are attained by providing a heat transfer unit formed of five generally horizontal, slightly inclined, tubes connecting with headers at each end and provided with common transverse fins having the major portion of their area beneath the tubes to provide more effective heat transmission between the tubing and the circulating air. Each tube contains three sleeves of wire gauze of varying fineness

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fitting tightly within the tubing and being in firm contact with each other. These sleeves are supported by a twisted perforated thin metal strip which serves as a core. The liquid is fed substantially equally to each of the sleeving assemblies by a capillary distributor provided in the upper header while a similar capillary device is provided in the lower header for draining the liquid from each of the sleeving assemblies in substantially equal proportion in the lower header. Gas or vapor preferably is circulated through or drawn from the tubes.

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

In the drawings:

Fig. 1 is an elevational view of an absorber with the end portions shown in section substantially as lines 1—1 of Fig. 2;

Fig. 2 is a sectional view taken along the lines 2—2 of Fig. 1; and

Fig. 3 is a fragmentary view showing the construction of one of the sleeving assemblies.

Referring now more particularly to Figs. 1 and 2, there are shown two supporting brackets 20 and 22 through which extend five slightly inclined tubes 24, 26, 28, 30 and 32. At the upper end, these tubes each extend into the transverse header 34 to which, through the tubes 36, is fed the weak liquor from the generator and heat exchanger. The opposite ends of the tubes extend into the lower header 38 from which the enriched liquid is removed through the tube 40 for return through the heat exchanger and fractionator to the generator. When used in a partial pressure absorption refrigerating apparatus, the mixture of the inert gas and refrigerant is fed from the evaporator and heat exchanger through the tube 42 to the lower header 38. The stripped inert gas is removed from the absorber and returned to the evaporator by the tube 44 which connects to the top of the upper header 34.

Each of the tubes preferably contains an identical capillary conduit such as is shown in Fig. 3. The core of the conduit is formed by a twisted perforated steel strip 46 over which is a wire gauze inner sleeve 48 formed of single braided wire sleeving consisting of 48 ends of .010 steel weaving wire with one end up. This first layer is primarily intended for the carrying of the liquid and to hold a large area of freely exposed liquid film.

The second sleeve 50 of wire gauze is designed to provide high capillarity to prime each sleeve

upon starting up the apparatus, so that through this layer each sleeving assembly will become entirely wetted with the liquid through capillary action. This second sleeve **50** tightly envelops the inner sleeve **48** and consists of multiple braided wire sleeving having **48** ends of .004 steel weaving wire with four ends up and eight picks.

The third sleeve **52** of wire gauze tightly envelops the second sleeve **50** and assists in the priming of the assembly; but also serves to carry liquid. This third sleeve **52** consists of single braided wire sleeving having **48** ends of .008 steel weaving wire with one end up.

One of these capillary conduits is forced into each of the tubes and fits snugly therein from one end of the tube to the other. The bottom of both ends of each of the tubes is notched as indicated by the reference characters **54** and **56**. Extending transversely across the upper header **34** beneath the notched portion **54** of each of the tubes is a capillary distributor **58**. This capillary distributor is formed of an upper roll **60** of wire gauze which is supported in contact with the bottom of each capillary conduit by the inverted channel-shaped supports **62** resting upon the bottom of the header **34**. To secure substantially equal distribution of liquid to this roll **60** when the liquid level is low, there is provided another stage of liquid distribution by means of the roll **64** of wire gauze which is clamped to the upper roll **60** by the clamps **66**. When the liquid is low, it is fed from the bottom of the header **38** through the lower roll **64** to the two particular points in the upper roll **60** wherein the liquid will be fed substantially uniformly to each of the capillary conduits in the five tubes.

In the lower header **38**, a similar distributor formed of an upper roll **68** and a lower roll **70** is provided so that the liquid may be drained uniformly from the tubes. After the capillary conduits are inserted in the tubes and the capillary distributors are placed in their proper position within the upper and lower headers **34** and **36**, the headers are each closed by a plate, such as the plates **72** and **74**, which are welded in place to seal the headers.

As the liquid flows through the capillary conduits from the upper header **34** to the lower header **38**, a mixture of refrigerant and inert gas flows through the interior of the conduits in the opposite direction. This inert gas is guided by the thin perforated steel strip **46** in a helical path so that it makes a wiping contact with the liquid on the inner surface of each capillary conduit. The presence of the perforations in the strip **46** promotes free flow of the mixture of inert gas and refrigerant through the interior of the capillary conduits. The size and/or number of perforations may be reduced to increase the wiping contact if the rate of gas flow is ample. The intimate contact between this mixture and the liquid causes the absorption of the refrigerant by the liquid. This is accompanied by the evolution of considerable heat and to promote this absorption the liquid must be kept cool.

For this purpose the five tubes are efficiently finned through the use of transverse fins **76** which are shared by all of the tubes to make the fins more efficient. Flanged apertures which receive each of the five tubes are provided about one-third the distance from the top of the fin so that the major portion of their area is beneath the tubes. This improves the efficiency of the fins since the upper portion of each of the fins is less effective because in its upward flow between the fins, the external cooling air is forced to flow around the tubing causing an unequal distribution of air-flow and particularly reducing the effectiveness of that portion of the fins located directly above each of the tubes. Also this external cooling air which passes by natural convection upwardly between the tubes has had added to it not only the heat transmitted to it by the lower portion of the fins, but also the heat transmitted directly to it by the tubing and the flanges of the fins which raises its temperature and thus lowers the heat transfer differential and rate between the upper portions of the fins and the external cooling air. Therefore more efficient heat transfer for gravity air-flow is provided by these unique fins.

While I have described this apparatus as an absorber, it may also be used as an evaporator by supplying the liquid to be evaporated to the upper header **34** and by removing the vapor produced by the evaporation of the liquid either through the lowering of the vapor pressure or through the circulation of stripped inert gas. The apparatus has a relatively large liquid surface exposed within each of the tubes and this liquid surface has good heat transfer through the wire gauze and through the walls of the tubing and the fins to the air. The liquid distribution and gas flow is excellent and the apparatus is easy to manufacture and low in cost.

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, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. Heat transfer apparatus including a plurality of tubes, substantially horizontal headers connecting the tubes at the opposite ends thereof, capillary means extending continuously within the tubes from one header to the other header, a unitary horizontal capillary conduit means extending horizontally within one header and contacting one end of each of the capillary means provided within the tubes, and means for feeding a liquid to said capillary conduit means to distribute the liquid flow to the individual capillary means within the tubes.

2. Heat transfer apparatus including a plurality of tubes, substantially horizontal headers connecting the tubes at the opposite ends thereof, capillary means extending continuously within the tubes from one header to the other header, a unitary horizontal capillary conduit means extending horizontally within one header and contacting one end of each of the capillary means provided within the tubes, a second capillary conduit means having an intermediate portion contacting the bottom of said header and having end portions contacting separated portions of said horizontal capillary conduit means, and means for feeding a liquid to said header to distribute the liquid flow through said second and first conduit means to each of the capillary means.

3. Heat transfer apparatus including a plurality of tubes, substantially horizontal headers connecting the tubes at the opposite ends thereof, capillary means extending continuously within the tubes from one header to the other header, a separate unitary horizontal capillary means extending horizontally within each header and contacting the adjacent end of each of the capillary means in the tubes, and means for feeding liquid to the capillary conduit means in one header

and draining the liquid from the capillary conduit means in the second header.

4. Heat transfer apparatus including a plurality of tubes, substantially horizontal headers connecting the tubes at the opposite ends thereof, capillary means extending continuously within the tubes from one header to the other header, a separate unitary horizontal capillary means extending horizontally within each header and contacting the adjacent end of each of the capillary means in the tubes, a second capillary conduit means in each header having an intermediate portion contacting the bottom of its header and having end portions contacting separated portions of the adjacent horizontal capillary conduit means, and means for feeding liquid to one of the headers and draining the liquid from the second header.

5. Heat transfer apparatus including a plurality of tubes, substantially horizontal headers connecting the tubes at the opposite ends thereof, capillary means extending continuously within the tubes from one header to the other header, a unitary horizontal capillary conduit means extending horizontally within one header and contacting one end of each of the capillary means provided within the tubes, and means for draining a liquid from said capillary conduit means.

6. Heat transfer apparatus including a plurality of tubes, substantially horizontal headers connecting the tubes at the opposite ends thereof, capillary means extending continuously within

the tubes from one header to the other header, a unitary horizontal capillary conduit means extending horizontally within one header and contacting one end of each of the capillary means provided within the tubes, a second capillary conduit means having an intermediate portion contacting the bottom of said header and having end portions contacting separated portions of said horizontal capillary conduit means, and means for draining a liquid from said header.

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