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FINNED TUBULAR HEAT EXCHANGE ELEMENTS AND QUICK FREEZING APPARATUS EMBODYING SUCH ELEMENTS

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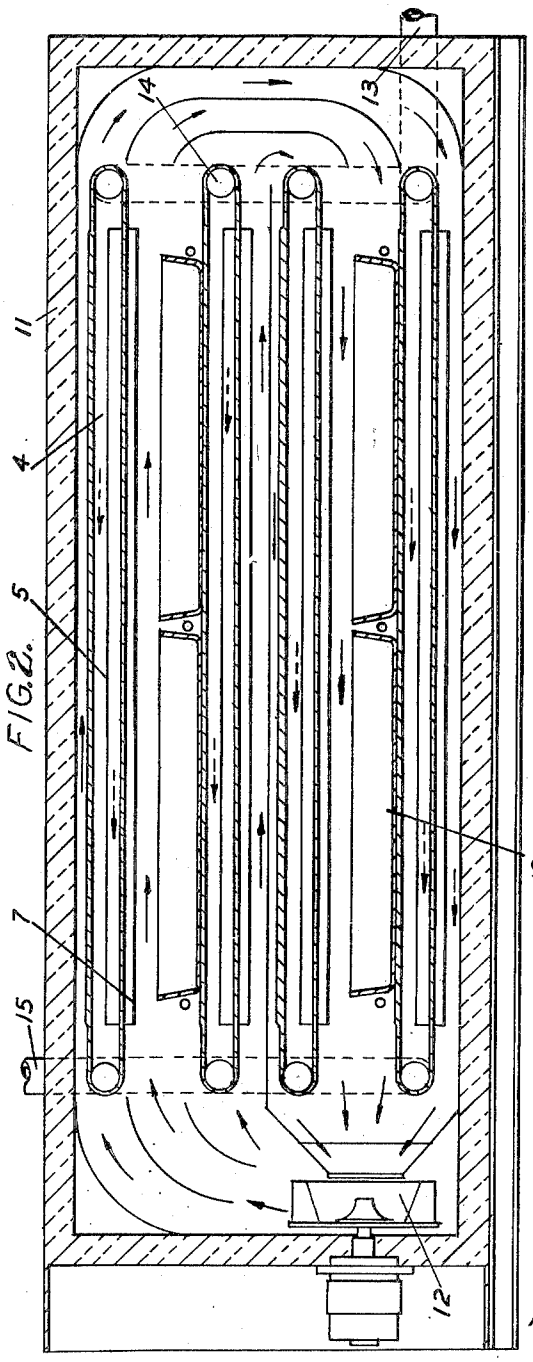

FIG. 2.

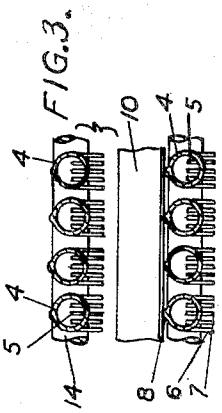

FIG. 3.

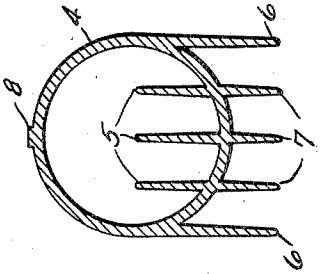

FIG. 1.

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FINNED TUBULAR HEAT EXCHANGE ELEMENTS AND QUICK FREEZING APPARATUS EMBODYING SUCH ELEMENTS

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6 Claims. (Cl. 62—102)

The present invention relates to heat exchange apparatus, and its main object is to increase the rate of heat transfer from one fluid medium to another, so as to increase the rapidity of change of relative temperature of the two media. If such apparatus operates over a low temperature range "quick freezing" may be obtained, but it may be adapted to operate over a high temperature range if desired.

A specific object of the invention is to provide means improving upon the known type of heat exchanger in which the heat exchange takes place through the wall of a hollow element through which a cooled or heated fluid medium flows, said element being embodied in a cooling or heating chamber containing a substance or article to be cooled or heated, or being immersed in another fluid medium to be cooled or heated. For refrigeration purposes, in the case of a liquid, the liquid to be cooled usually constitutes one of two fluid media flowing over and through the heat exchange elements, but, in the case of solids or substances packed in containers, a fluid medium flowing over the heat exchange element or elements may also circulate over the solids or containers to be cooled, so that there is a secondary exchange of heat between the solids or containers and the fluid medium cooled by the heat exchange element. In addition there may be a direct exchange of heat between the heat exchange element itself and the solids or containers, if the latter, while being immersed in the cooled fluid medium, are placed in surface contact with the heat exchange elements.

It has been found that the efficiency of heat exchange apparatus when used for example, for refrigeration, using refrigerated or chilled liquid, such as brine, as the low temperature medium, and an air current as the other fluid medium to be cooled, is greatly enhanced if fins are provided longitudinally on the heat exchange tubular elements and parallel to the direction of flow of the air current.

In accordance with the present invention the rate of heat transfer, and thus the rapidity of change of temperature induced thereby is still further enhanced by providing longitudinal fins in the interiors of the hollow heat exchange elements, which run parallel, or substantially parallel, to the direction of flow of the internal fluid medium passing through the elements.

Another important feature of the invention consists in an improved construction of heat exchange tubes in regard to the external fins, according whereto the external fins are arranged in spaced relation parallel to one another along the tube and at right angles to a diameter of the tube.

An embodiment of the invention is illustrated in the accompanying drawing which shows, solely by way of example, how the invention may be carried into practice. In the drawing:

Figure 1 is a cross sectional view of one construction of tubular heat exchange element according to the invention.

Figure 2 is a longitudinal section of a cooling or temperature reducing cabinet embodying the improved heat exchanging elements according to the invention, and

Figure 3 is a partial cross sectional view through the shelves of the cabinet shown in Figure 2.

Referring now more particularly to the attached drawing, Figure 1 illustrates a construction in which the tube 4 has continuous longitudinal internal fins 5 which are parallel to one another and to the tube axis, with the number of internal fins 5 less than the number of external fins 6, 7. The outer external fins 6, are tangential to the periphery of the tube 4 i. e. spaced apart at a distance equal to the diameter of the tube, whilst the inner external fins 7 are of varying heights such as to bring their tips into alignment with the plane of the tips of the outer fins 6, 6. The internal fins 5 are shown equal in number to, and in alignment with the intermediate external fins 7, but they may be staggered in relation thereto, if desired, or different in number. Along the upper side of the tube 4, which may be otherwise free from external ribs, is a raised longitudinal rib member 8, which allows for wear on the surface of the tube when sliding containers are used to reserve the goods from which heat is to be extracted, or to which heat is to be added.

The tubular members may be cast with their fins or ribs integral therewith, or in the case of the internal fins these may be formed by the insertion into the tubes of sheet metal members suitably shaped or bent to form the longitudinal fins.

In the embodiment of tubular members in accordance with this invention in a heat exchanging apparatus, they may be disposed in a heat insulating cabinet, either in contact with one another, or in spaced parallel relationship. Preferably the tubular members are disposed side by side, in contact or in spaced relation, to form shelves for the support of goods to be cooled (or heated). Suitable pipe connections are provided for the ends of the tubular members to cause the circulation of the fluid therein in the desired manner, either in series, or in parallel, or in series-parallel groups.

One example of cooler or freezer embodying the invention is illustrated by Figures 2 and 3.

The freezer housing consists of a chamber 11 having four banks or groups of tubular heat exchanging elements according to the invention, arranged as shelves one above the other in spaced relationship, as shown. The tubular members are of the form illustrated in Figures 1 and 3, with internal fins 5 and depending external fins 6, 7. The tubular members 4 are arranged close together, but not necessarily in contact, as shown in Figure 3. The tubes are connected at their ends by pipes 14, and a liquid or gaseous cooling medium is supplied through inlet pipe 13 and discharged through outlet pipe 15.

The air contained within the chamber 11 is circulated by a fan 12, as directed by baffles at the two ends of the cabinet or chamber 11, so as to flow along the tubes 4, passing in parallel along the two upper banks of tubes to the right hand end of the cabinet or chamber 11, and returning to the fan 12 in parallel along the two lower banks of tubes. It will be noted that the liquid medium passes upwardly through the cabinet 11 from inlet 13 to outlet 15, whilst the air circulation is in the reverse direction i. e. from the top downwardly.

The goods to be frozen are either placed directly on the shelves formed by the two lower banks of tubes 4 in the upper and lower sections of the cabinet, or are placed in metal trays or containers 10, which are placed on the shelves. Thus heat is extracted from the goods partly by direct conduction through the tubes 4, but mainly by the air passing over them, which air is at the same time in heat conductive contact with the lower sides

of the tubes 4 and their fins 6, 7, above the containers 10, and with the remaining surfaces of the tubes 4 on which the containers stand.

It will be appreciated that the rate of heat transfer from the goods to the air will depend upon the velocity of the air current, whilst the rate of transfer of heat from the air to the medium passing through the pipes 4 will depend upon the external and internal surface areas of the tubes, which will be naturally increased by the fins therein or thereon. Consequently the speed of the air current can be raised in comparison with existing practice and the rate of cooling of the goods correspondingly increased.

Although more than one embodiment of the invention has been described and shown in the drawing, it should be noted that the invention may be realized in modified form and adaptations of the arrangements herein disclosed may be made as may readily occur to persons skilled in the art without constituting a departure from the spirit and scope of the invention as defined in the objects and in the appended claims.

Various changes and modifications may be made without departing from the spirit and scope of the present invention and it is intended that such obvious changes and modifications be embraced by the annexed claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent, is:

1. A quick freezing apparatus comprising a heat insulated housing having a chamber, a plurality of shelves in said chamber disposed in spaced relation and one above the other, said shelves including adjacent tubes alternately connected at opposite ends thereof, means for circulating a fluid cooling medium through said tubes, baffle means located in said chamber, means for circulating a current of air in a closed circuit within said chamber, said current of air being directed by said baffle means along the outside of said tubes in the spaces between said shelves, said tubes being provided with depending outer fins on the lower surfaces of said shelves, said outer fins being substantially parallel to each other and longitudinally on said tubes, and internal longitudinally disposed fins extending within said tubes, said depending outer fins being provided with a predetermined depth in order that the surface area of said depending fins permit a rate of heat gain from the circulating air substantially equal to the rate of heat loss to the fluid medium permitted by the surface area of said internal fins.

2. A quick freezing apparatus comprising a heat insulated housing having a freezing chamber, a plurality of shelves in said chamber disposed in spaced relation one above the other, said shelves including adjacent tubes alternately connected at opposite ends thereof, means for circulating a fluid cooling medium through said tubes, a system of baffles in said chamber, means for circulating a current of air in a closed circuit within said chamber, said current of air being directed by said baffles along the outside of said tubes and in the spaces between said shelves, said tubes being provided with depending outer fins located on the lower surfaces of said shelves and having a predetermined depth, said outer fins being disposed parallel to each other and longitudinally on said tubes, and internal longitudinally disposed fins extending within said tubes for increasing the internal surface area of said tubes in direct and substantially equal proportion to the external surface area of said tubes, whereby the heat gain and loss of said tubes is equalized, while

the heat transfer rate between the circulating fluid medium and air is increased.

3. A quick freezing apparatus comprising a heat insulated housing having a freezing chamber, a plurality of shelves in said chamber spaced one above the other to support the goods to be frozen, said shelves being provided with externally finned tubular members through which a fluid cooling medium is circulated, baffle means in said chamber, and a fan for driving a current of air directed by said baffles through the spaces between said shelves, said tubular members being provided with internal fins in order to increase the heat absorbing surface between the fluid medium and said tubular members, and parallel external fins depending from said tubular members at right-angles to the horizontal diameter thereof, said fins being provided with a surface area which substantially equalizes the rate of heat gain afforded by the external finned surface of said tubular members with the rate of heat loss afforded by the internal finned surface of said tubular members.

4. A heat exchange apparatus having a freezing chamber and a plurality of shelves for supporting goods in said chamber, said shelves being provided with spaced surfaces and comprising means for circulating a heat exchange medium between the goods and said surfaces of said shelves, said shelves including adjacent and parallel tubular members through which a liquid heat exchange medium is circulated, said tubes being provided with continuous internal fins and with continuous external longitudinal fins depending in parallel relationship from and at right-angles to said surfaces of said shelves.

5. A heat exchange apparatus comprising a plurality of shelves having spaced surfaces for supporting goods, means for circulating a current of air over said surfaces of said shelves and over the goods thereon, said shelves including a plurality of adjacent tubes alternately connected together at opposite ends thereof, means for circulating a liquid heat exchange medium through said tubes, said tubes being provided with continuous inner fins therewithin and with continuous external fins depending in parallel relationship from the lower sides thereof at right-angles to said surfaces of said shelves.

6. A quick freezing apparatus comprising an outer heat insulating housing, a shelf in said housing built up of side by side tubular elements, external and longitudinal parallel fins depending from the lower sides of said elements disposed at right angles to the plane of the shelf, internal longitudinal parallel fins within said tubular elements, means for circulating an air current longitudinally over the surface of said tubular elements and said internal and external fins, and means for circulating fluid coolant through said elements.

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