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HEAT EXCHANGE DEVICE FOR CORROSIVE LIQUORS

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FIG. 1

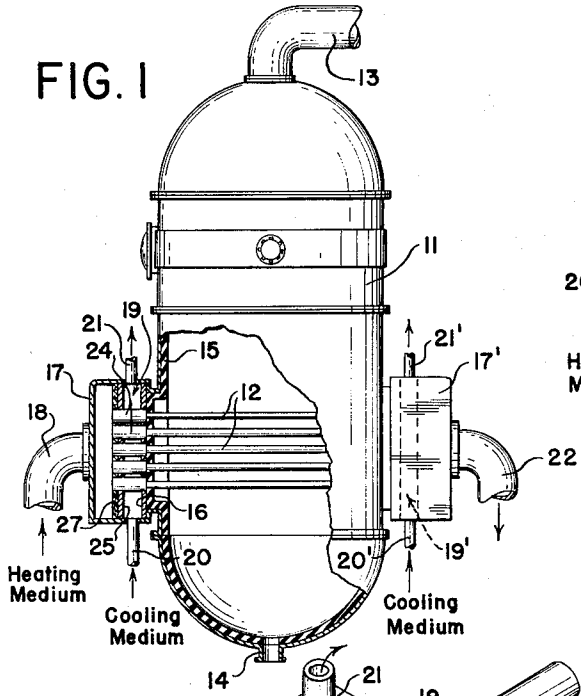



FIG. 3

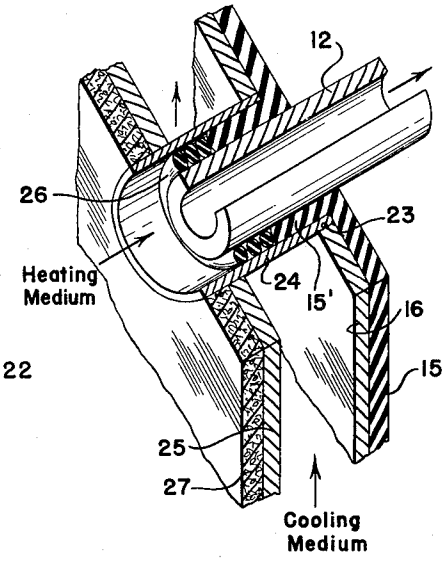
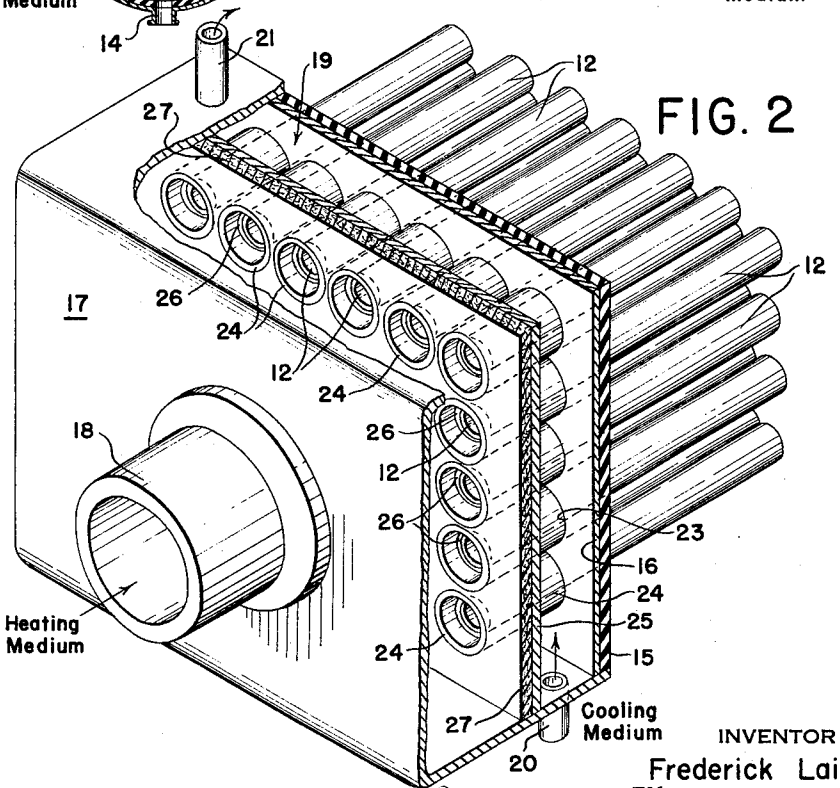



FIG. 2




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# HEAT EXCHANGE DEVICE FOR CORROSIVE LIQUORS

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This invention relates to heat exchange devices for corrosive liquors, and has for its object the provision of an improved heat exchange device for handling corrosive liquors.

In the evaporation or heating of acidic and other corrosive liquors, it is usually necessary to provide the receptacle containing the corrosive liquor with a corrosion-resistant lining. Linings of glass and porcelain are effective, but subject to breakage, and therefore not suitable for many industrial operations. Linings of rubber, neoprene and the like may also be effectively used in many applications, but are subject to the disadvantage that much of their resistance to the corrosive liquor is lost at higher temperatures. The object of this invention is to provide an improved heat exchange device for handling corrosive liquors in which the liquor receptacle has a corrosion-resistant lining of rubber or the like and is provided with means for maintaining the lining within a prescribed temperature range so that its effectiveness is assured.

In accordance with the invention, a suitable heating means, such as a plurality of corrosion-resistant heating tubes, extends through the receptacle (having a rubber-like lining) between opposite walls thereof, and at least that wall proximate the heat supply is artificially cooled. Preferably, both of the opposite walls of the receptacle between which the heating means extends are artificially cooled. More specifically, the invention contemplates an enclosed space or chamber intermediate each opposite wall of the receptacle and an adjacent manifold for the supply and exhaust, respectively, of a heating medium to the heating tubes, with means for circulating a cooling medium through each enclosed space.

The foregoing and other objects of the invention will be best understood from the following description taken in conjunction with the accompanying drawing, in which

FIG. 1 is a side elevation, partly in section, of an evaporator embodying the invention;

FIG. 2 is a perspective section showing the mounting of the heating tubes at one wall of the evaporator of FIG. 1, and

FIG. 3 is a fragmentary perspective section illustrating further details of the mounting of the heating tubes.

The evaporator shown in the drawing is generally of conventional design, being classified as a surface-type evaporator. It comprises a shell or receptacle **11** for containing the corrosive liquor to be evaporated. A plurality of heating tubes **12** pass through the receptacle **11** and in the normal operation of the evaporator are submerged in the liquor. In operating the evaporator, steam or other suitable heating medium is passed through the tubes **12**, and the liquor in the receptacle **11** is thus heated (usually under reduced pressure) to a sufficiently high temperature to vaporize a volatile component of the liquid. Vapor is drawn off through an outlet **13** at the upper end of the receptacle **11**, and a concentrate is discharged through an outlet **14** at the bottom of the receptacle. The operation may be either continuous or intermittent (i.e. batch-type).

The receptacle **11** is customarily made of steel or other suitable metal, and when handling corrosive liquors, such, for example, as an aqueous solution of hydrochloric acid or a solution of aluminum chloride containing hydrochloric acid, it is essential that the interior of the receptacle be provided with a lining which will resist the corrosive action of the acid. Natural rubber, neoprene and similar rubber-like materials have the necessary corrosion-resistance, and can be readily molded to conform with and be firmly bonded to the interior walls of the receptacle. Such a rubber-like lining is also highly advantageous in that it is not subject to fracture or breakage, as are glass and porcelain linings.



While rubber-like linings possess the aforementioned advantages, they lose their corrosion resistance if maintained at temperatures above about 200° F. In the case of neoprene the corrosion resistance begins to diminish at temperatures much above 150° F., although up to that temperature its corrosion-resistance is higher than that of natural rubber. Since as usually operated the interior of the receptacle **11** will be maintained under a considerable vacuum, the vaporizing or boiling temperature of the liquor contained therein need not exceed the aforementioned critical temperatures. However, since it is desirable to employ steam at a temperature of about 240° F. as the heating medium, substantial problems are involved in the use of rubber-like linings since the highly heated tubes **12** pass through opposite walls of the receptacle **11** and hence through the lining thereon. Where the lining is in contact with the heated tubes it begins to fail, and eventually the entire lining is rendered worthless. In accordance with the present invention, this difficulty is overcome by artificially cooling that portion of the wall of the receptacle **11** through which pass the heating tubes **12**.

The heating tubes **12** extend between and through opposite walls **16** of the receptacle. At one end, the tubes communicate with a manifold or header **17** which is supplied with a heating medium, e.g. steam, through an inlet pipe **18**. The manifold **17** is positioned in spaced relation with the adjacent wall **16**. The space between the manifold and adjacent wall **16** is enclosed to form a cooling chamber **19** intermediate the manifold and the receptacle. The manifold **17** and chamber **19** may advantageously be of unitary construction with an integral external wall welded or otherwise suitably secured to the adjacent wall **16** of the receptacle **11**. The chamber **19** is provided with fluid inlet and outlet pipes **20** and **21**, respectively, for a suitable cooling medium such as air, water, or the like. The other ends of the heating tubes **12** extend through an intermediate cooling chamber **19'** (similar to chamber **19**) into a manifold or header **17'** having an outlet pipe **22** for exhaust of the heating medium. The chamber **19'** (like chamber **19**) is provided with fluid inlet and outlet pipes **20'** and **21'**, respectively.

The openings **23** (FIG. 3) in the wall **16** of the receptacle, through which the heating tubes **12** extend, are of greater diameter than the external diameter of the tubes. Metal sleeves or thimbles **24** fit in the openings **22** and extend outwardly through the chamber **19** to a slight distance beyond the outer wall **25** of the chamber. The sleeves **24** are welded or otherwise suitably secured to the walls **16** and **25**. The rubber-like lining **15** has tubular extensions **15'** snugly fitting the space between each tube **12** and its surrounding sleeve **24**. The tubes **12** terminate short of the ends of the sleeves **24**, and the extensions **15'** terminate short of the tubes **12**. Packing rings **26** surround the ends of the tubes **12** to complete a hermetical seal of the tube in the wall **16**. In vacuum equipment such as herein described, it is necessary that the receptacle **11** be gas and liquid tight, since otherwise the vacuum might pull the lining away from the receptacle at any point of leak.

In operating the evaporator shown in the drawing, a heating medium such as highly heated steam (say 240°

F.) is supplied to the pipe 18, flows through the heating tubes 12 and is exhausted through the pipe 22. The tubes 12 are made of a corrosion-resistant material which additionally is a good conductor of heat. A graphitic compound known by the trade name of "Karbate" has been found suitable for the purpose. Air or other cooling medium is supplied to the chambers 19 and 19' through the pipes 20 and 20' and exhausted through the pipes 21 and 21', respectively. The cooling chambers 19 and 19' thus maintain the adjacent walls (16) of the receptacle at a sufficiently low temperature to avoid deterioration of the rubber-like lining 15. In order to minimize cooling of the heating medium in the manifold 17 through contact with the adjacent cooling chamber 19, the wall 25 (between the manifold and cooling chamber) is preferably provided with an external layer of heat insulating material 27, such as a mixture of Portland cement or magnesium oxychloride cement with asbestos. Extension of the sleeves 24 slightly beyond the outer wall 25 assists in firmly holding the insulating material 27 on the wall.

When a cooling medium is circulated through the enclosed spaces 17 and 17', the under surface of the rubber-like lining 15 proximate the heating tubes 12 will be kept at a lower temperature than that of the liquor undergoing evaporation in the receptacle 11. In evaporating acidic aluminum chloride liquors, the liquor temperature within the evaporator is usually held within the range of 140–150° F., by maintaining the vacuum within the receptacle 11 as near to theoretical as practical. However, the invention permits operating an evaporator at liquor temperatures up to about 190° F. without objectionable over-heating of the rubber-like lining.

The invention is readily embodied in heat exchange apparatus of otherwise standard design, at relatively low cost. While effectively protecting a rubber-like lining from danger of failure due to overheating in the areas of contact with the heating means, the artificial cooling contemplated by the invention abstracts only a negligible amount of heat from the heating means. The end portions of the heating tubes 12 which pass through the cooling chamber 17 are effectively heat-insulated by the extensions 15' of the lining and the packing rings 26, while loss of heat from the manifold 17 through the wall 25 is minimized by the layer of heat insulation 27 on the wall. Hence the invention does not adversely affect the heat efficiency of the evaporator.

I claim:

1. A heat exchange device for handling corrosive liquors comprising a receptacle having a corrosion-resistant lining of rubber-like material, means for introducing into the receptacle and withdrawing therefrom the corrosive liquor to be handled by the device, a plurality of corrosion-resistant heat exchange tubes extending between and through opposite walls of said receptacle, manifolds communicating respectively with the opposite ends of said tubes and positioned respectively in spaced relation with said opposite walls of the receptacle, the space between each manifold and the adjacent wall of the receptacle being enclosed to form a cooling chamber, means for supplying a cooling medium to each of said cooling chambers, means for supplying a heating medium to one of said manifolds and for withdrawing the heating medium from the other manifold, each of said manifolds and the adjacent cooling chamber having a common wall provided with heat insulation, and heat insulation surrounding those portions of the heating tubes which are positioned within said cooling chambers.

2. A heat exchange device for bringing corrosive liquor into heat exchange relation with a heating medium comprising a receptacle adapted to contain the liquor and having walls comprising a corrosion-resistant material which is subject to deterioration when heated to the maximum temperature of the heating medium, a plurality of corrosion-resistant heating tubes extending through said receptacle and through opposite walls thereof, heating medium inlet and exhaust manifolds mounted in spaced relation with said walls, the heating tubes extending beyond said receptacle walls and into communication with the interiors of said manifolds, means for delivering heating medium into one of said manifolds and for exhausting spent heating medium from the other thereof, and means for introducing a cooling fluid into the space between each manifold and the adjacent receptacle wall.

3. A heat exchange device for bringing corrosive liquor into heat exchange relation with a heating medium comprising a receptacle having walls comprising a corrosion-resistant material which is subject to deterioration when heated to the maximum temperature of the heating medium, means for introducing into the receptacle and withdrawing therefrom the corrosive liquor, a plurality of corrosion-resistant heat exchange tubes extending between and through opposite walls of said receptacle, a heating medium inlet manifold comprising a tube header wall mounted in spaced relation with one of said receptacle walls, the space between said header wall and the adjacent receptacle wall being enclosed and forming a cooling chamber, the heat exchange tubes extending through said cooling chamber and through said header wall and opening into said inlet manifold, cooling fluid inlet and outlet means communicating with said cooling chamber, means for supplying heating medium to said manifold, and a heating medium exhaust manifold with which the other ends of said tubes communicate and having exhaust means for the heating fluid.

4. A heat exchange device for bringing corrosive liquor into heat exchange relation with a heating medium comprising a receptacle having walls comprising a corrosion-resistant material which is subject to deterioration when heated to the maximum temperature of the heating medium, means for introducing into the receptacle and withdrawing therefrom the corrosive liquor, a plurality of corrosion-resistant heat exchange tubes extending between and through opposite walls of said receptacle, a heating medium inlet manifold comprising a tube header wall mounted in spaced relation with one of said receptacle walls, said header wall comprising a layer of heat insulating material, the space between said header wall and the adjacent receptacle wall being enclosed and forming a cooling chamber, the heat exchange tubes extending through said cooling chamber and through said header wall and opening into said inlet manifold, cooling fluid inlet and outlet means communicating with said cooling chamber, means for supplying heating medium to said manifold, and a heating medium exhaust manifold with which the other ends of said tubes communicate and having exhaust means for the heating fluid.

5. A heat exchange device for bringing corrosive liquor into heat exchange relation with a heating medium comprising a receptacle having walls comprising a corrosion-resistant material which is subject to deterioration when heated to the maximum temperature of the heating medium, means for introducing into the receptacle and withdrawing therefrom the corrosive liquor, a plurality of corrosion-resistant heat exchange tubes extending between and through opposite walls of said receptacle, a heating medium inlet manifold comprising a tube header wall mounted in spaced relation with one of said receptacle walls, a heating medium exhaust manifold comprising a tube header wall mounted in spaced relation with the opposite of said receptacle walls, the spaces between said header walls and the respective receptacle walls being enclosed and forming cooling chambers, the heat exchange tubes extending through each of said cooling chambers and through said header walls and opening into said manifolds, said heat exchange tubes where they extend through said cooling chambers being surrounded by material of relatively low heat conductivity, cooling fluid inlet and outlet means communicating with each of said cooling chambers, means for supplying heating medium to said

inlet manifold, and means for removing spent heating medium from said exhaust manifold.

6. A heat exchange device for handling corrosive liquor comprising a metallic receptacle having a lining of rubber-like material, means for introducing into the receptacle and withdrawing therefrom the corrosive liquor to be handled, a plurality of corrosion-resistant heat exchange tubes extending between and through opposite walls of said receptacle, a heating medium inlet manifold comprising a tube header wall mounted in spaced relation with one of said receptacle walls, the space between said header wall and the adjacent receptacle wall being enclosed and forming a cooling chamber, the heat exchange tubes extending through said cooling chamber and through said header wall and opening into said inlet manifold, means for introducing cooling fluid into said cooling chamber into direct contact with the metallic component of the lined receptacle wall, means for supplying heating medium to said manifold, and a heating medium exhaust manifold with which the other ends of the said tubes communicate and having exhaust means for the heating fluid.

7. A heat exchange device for handling corrosive liquor comprising a metallic receptacle having a lining of rubber-like material, means for introducing into the receptacle and withdrawing therefrom the corrosive liquor to be handled, a plurality of corrosion-resistant heat exchange tubes extending between and through opposite walls of said receptacle, a heating medium inlet manifold comprising a first tube header wall mounted in spaced relation with one of said receptacle walls, a heating medium exhaust manifold comprising a second tube header wall mounted in spaced relation with the opposite of said receptacle walls, the spaces between said header walls and the respective receptacle walls being enclosed and forming cooling chambers, the heat exchange tubes extending through each of said cooling chambers and through said header walls and opening into said manifolds, said heat exchange tubes where they extend through said cooling chambers being surrounded by a layer of said rubber-like material, means for introducing cooling fluid into said cooling chambers into direct contact with the metallic component of the lined receptacle wall, means for supplying heating medium to said inlet manifold, and means for removing spent heating medium from said exhaust manifold.



8. A heat exchange device for bringing corrosive liquor into heat exchange relation with a heating medium comprising a receptacle adapted to contain the liquor and having walls comprising a corrosion-resistant material which is subject to deterioration when heated to the maximum temperature of the heating medium, a plurality of corrosion-resistant heating tubes extending through said receptacle and through opposite walls thereof, heating medium inlet and exhaust manifolds mounted in spaced relation with said walls, the heating tubes extending beyond said receptacle walls and into communication with the interiors of said manifolds, sleeves surrounding the end portions of the heat exchange tubes and bridging the spaces between the manifolds and the respective receptacle walls, said sleeves having a larger cross sectional diameter than the heat exchange tubes, heat insulating material interposed between said sleeves and the end portions of the heat exchange tubes which they surround means for delivering heating medium into one of said manifolds and for exhausting spent heating medium from the other of said manifolds, and means for introducing a cooling fluid into the space between each manifold and the adjacent receptacle wall.

9. A heat exchange device as set forth in claim 8 in which the receptacle has a rubber-like lining and the heat insulating material interposed between said sleeves and said end portions of the heat exchange tubes is also of rubberlike material and integral with said lining.

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