June 10, 1930. R. L. SHIPMAN 1,763,012

ECCENTRIC CONCENTRIC HEAT EXCHANGER

Filed Oct. 9, 1928 2 Sheets-Sheet 1

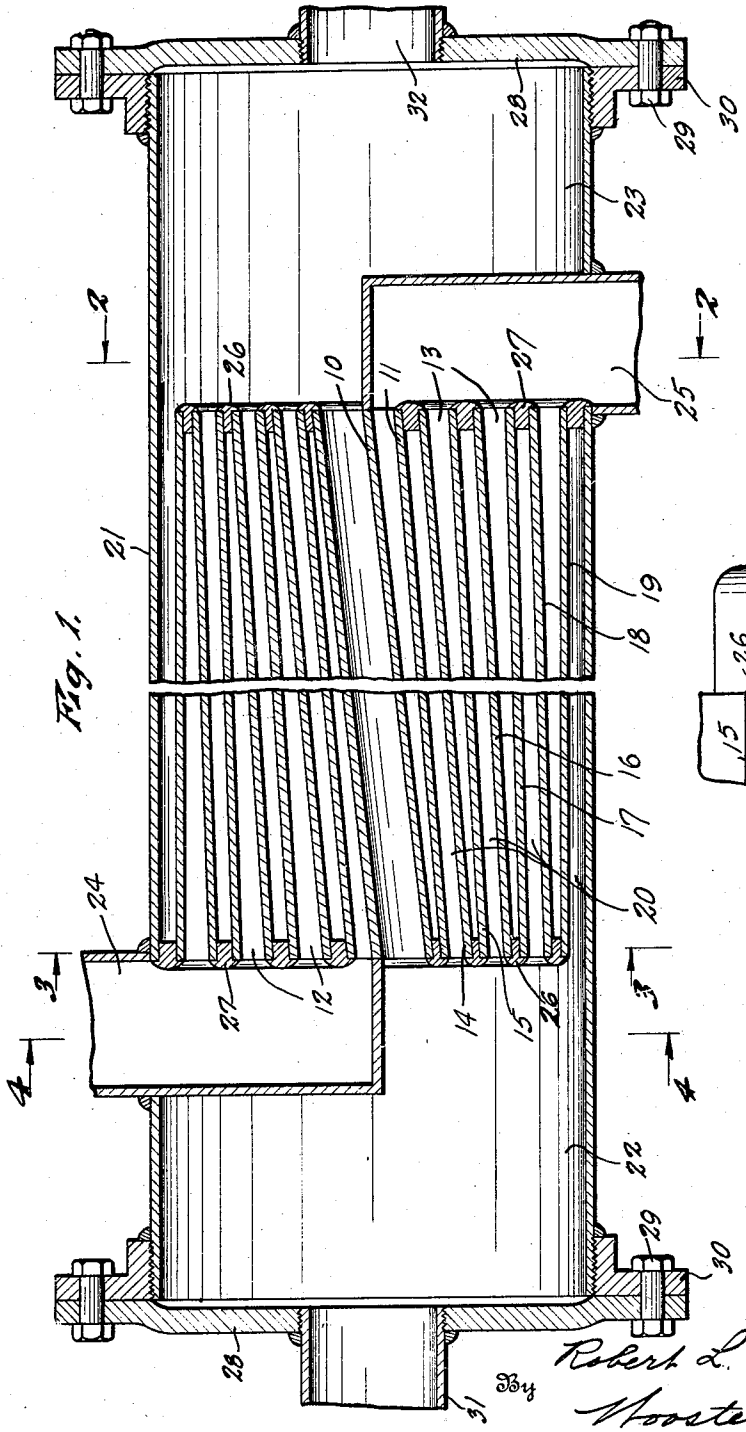


Fig. 1.

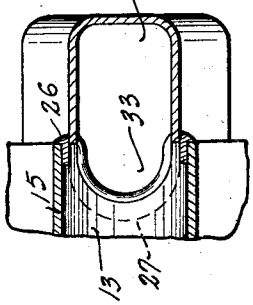


Fig. 5.

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ECCENTRIC CONCENTRIC HEAT EXCHANGER

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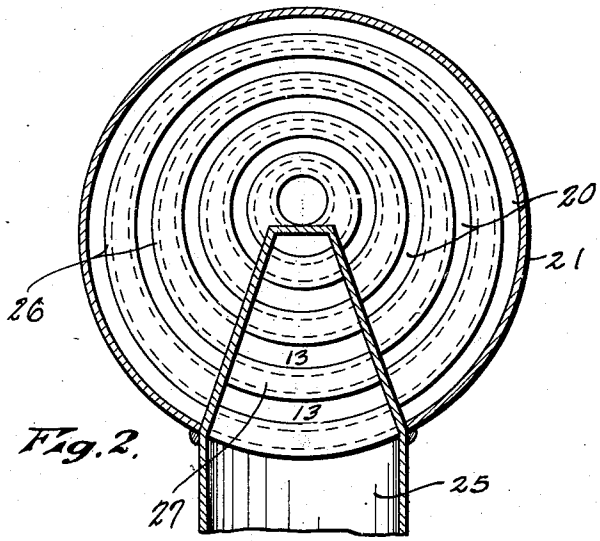


Fig. 2.

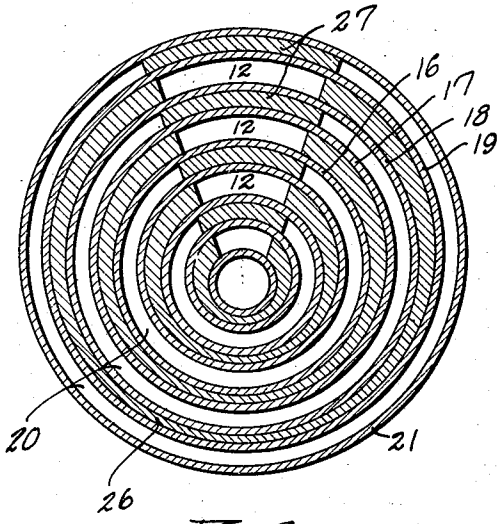


Fig. 3.

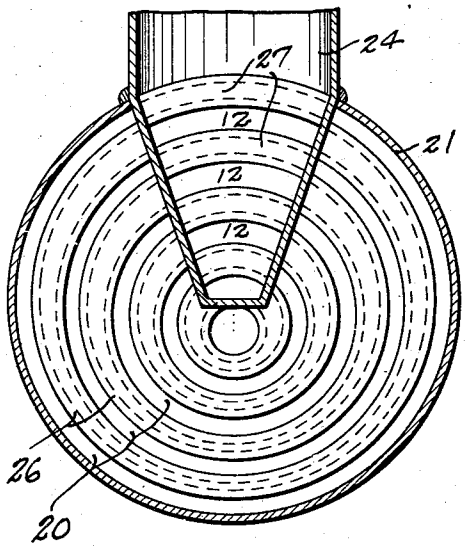


Fig. 4.

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UNITED STATES PATENT OFFICE

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ECCENTRIC-CONCENTRIC HEAT EXCHANGER

Application filed October 9, 1928. Serial No. 311,382.

This invention relates to a heat exchanger or a heat exchange device for the transfer of heat from one fluid medium to another through intervening walls, and has for an object to provide a device which will require a minimum amount of space for a given amount of heat transfer surface.

It is also an object of the invention to provide a device of this character in which practically all of the material entering into the construction is used for heat transfer purposes, thus economizing in the amount of material required for a given heat transfer capacity.

It is a further object of the invention to provide a device in which the surfaces liable to be corroded by electrolytic action may be protected, and where all the joints are easily accessible for inspection or repair.

It is another object of the invention to so construct a device of this character that the condensing medium is in thin layers over the active surfaces to reduce to a minimum the amount of the condensing liquid required, and to also economize in the amount of power required for circulating the condensing medium.

It is a still further object of the invention to provide a device of this character in which all spaces containing a certain medium, such as poisonous gases or vapors, are surrounded by the condensing medium, such as water, so that should there be any leakage of the poisonous gases or vapors it would be into the water, and therefore, carried away with it without danger to life or property.

It is another object of the invention to so arrange the elements forming relatively narrow fluid conducting spaces that the fluid inlet and outlet conductors to these spaces may be connected across the ends thereof and still have sufficient opening between the conductors and the spaces to permit an effective flow of fluid.

With the foregoing and other objects in view the invention consists in certain novel features of construction, combinations and arrangements of parts as will be more fully described in connection with the accompanying drawings. In these drawings,

Fig. 1 is a longitudinal section of a heat exchanger constructed according to my invention.

Figs. 2, 3 and 4 are transverse sections thereof substantially on lines 2—2, 3—3 and 4—4 respectively of Fig. 1, and

Fig. 5 is a fragmentary section showing a slightly different construction.

The device illustrated comprises a plurality of tubes of progressively increasing diameter arranged one within the other and spaced from each other to provide passages for the fluids. Where concentric tubes were used one of the difficulties involved, especially where these spaces were narrow, was to connect the inlet and outlet pipes for the fluids in such a way as to provide sufficient openings for the passage of the fluids between the pipes and the spaces. Especially was this true where the inlet and outlet pipes were extended across the ends of the spaces. In the present construction I have to a large extent overcome this difficulty by arranging the tubular elements in the manner shown, and in which the elements are inclined so as to increase the width of the spaces at one side where they are in communication with the inlet or outlet pipe or conduit.

To secure this result I have arranged the tubular elements in what I call cells, each cell being formed by a pair of tubes of different diameters arranged one within the other so as to provide a space between them, and the axes of these tubes being inclined to each other so that the opposite ends of the tubes are eccentric and the space between the tubes at one end is greater on one side of the axes than on the other side and the space between the tubes at the other end is greater on the opposite side of the axes. Take for example, the inner tube 10 and the next larger tube 11. These two tubes form the inner cell and their axes are inclined to each other so that their opposite ends are eccentric, and therefore, the portion of the space 12 at the upper side and at the left end of Fig. 1 is wider than the

space at the lower side of the tube 10, while at the opposite end the lower portion of this space is wider, as shown at 13, than the space is at the upper side of the tube. The same is true of the second cell comprising the tubes 14 and 15. The axes of these tubes are also inclined to each other so that they are eccentric at opposite ends to give wider spaces 12 and 13 at the upper and lower sides of the tubes at their opposite ends, the same as in the first form. The tubes 16 and 17 of the next cell are arranged the same way, as are also the tubes 18 and 19 of the outer cell. However, in assembling the cells they are arranged so that there are spaces between the respective cells which are substantially annular, that is the outer tube 11 of the inner cell is concentric with the inner tube 14 of the next larger cell, and the outer tube 15 of the second cell is concentric with the inner tube 16 of the next larger cell, and so on, so that the spaces 20 between the larger tube of one cell and the smaller tube of the next larger cell is a substantially annular space and of the same width throughout.

The assembled structure is enclosed in an outer cylindrical shell 21 and the outer tube 19 is concentric with this shell to provide a similar space 20 between them. The tubes of the cells are shorter than the shell 21 providing spaces or chambers 22 and 23 at the opposite ends of the cells, and the annular spaces 20 communicate with the chambers 22 and 23 at their opposite ends, and as these spaces may be opened throughout the greater portions of their peripheries these spaces 20 may be left annular. The spaces between the tubes of the cells are connected with fluid conducting pipes 24 and 25, one of which is the inlet pipe and the other the outlet pipe. As these pipes are relatively small in diameter considerable difficulty, as pointed out above, has been experienced in securing sufficiently large openings between the conductors and the required spaces to secure the proper flow of fluid through the device. However, by connecting the pipe 24, for instance, with the portions 12 of the cell spaces and the pipe 25 to the widest portions 13 of the cell spaces I am enabled to secure a sufficiently large opening between these spaces and the conduits to secure a very effective flow of fluid between them, and I can secure sufficient flow even though the conduits extend across the ends of the tubes as shown. This greatly simplifies the construction and reduces the cost of manufacture. It will, of course, be understood that the ends of the cell spaces which are not in communication with the conduits 24 and 25 are closed against the chambers 22 and 23, and it is preferred to secure this closure by welding them together, as indicated at 26. It will also be understood that the ends of the annular spaces 20 are open to the chambers 22 and 23 except where they are opposite the conduits 24 and 25 and here they are welded together, as shown at 27, so that the spaces 20 are not in communication with the conduits 24 and 25, and the two streams of fluid between which there is a transfer of heat are kept separate.

The opposite ends of the shell 21 may be closed by heads 28 bolted by suitable bolts 29 to flanges 30 secured to the opposite ends of the shell, and inlet and outlet conduits 31 and 32 may be connected to these heads to conduct fluid to and from the chambers 22 and 23.

To secure a more uniform distribution of the fluid to the cell spaces 12 and 13, the conduits 24 and 25 may be tapered as shown in Figs. 2, 3 and 4, the smallest ends being in communication with the inner smallest diameter 12 or 15 and the greatest width in communication with the corresponding space of the largest diameter, it being, of course, understood that the largest diameter space is capable of conducting a greater amount of fluid.

These devices may be made in practically any length desired to give the required surfaces, or they may be made up of certain lengths and connected together either in series or parallel to secure the same result. It will be apparent that there are numerous advantages in this construction over the constructions of the ordinary heat exchangers. For instance, it is very economical in the space required as there are practically no waste spaces in its makeup, and it requires a minimum of space in proportion to the amount of heat transfer surface secured. This is a particular advantage in congested districts where space is valuable. This feature also is economical of material as practically all the material used in its construction is active material functioning for transfer of heat, and the walls may be placed closely together. The construction is also relatively inexpensive as all the joints can be welded, and therefore, fittings or screw joints are not required, and the units can be built up into practically any desired size thus requiring a minimum of header construction.

The device is also, furthermore, of long life as it is compact with the material in close assembly and it can thus be easily protected against deterioration by electrolytic action, such for instance, as the use of zinc where salt water or brine is used. It will be noted that all joints are easily accessible for inspection or repair, and therefore, the cost of upkeep is reduced.

A further advantage of this device is economy in the use of condensing medium. It will be noted from the drawing that

water, for instance, used as a condensing medium passes through the annular spaces 20 and it is, therefore, disposed in thin layers over the active surfaces. The same is true of the material, such as gases or vapors, to be condensed or cooled in the cell spaces 12—13, but in cases such as this in which vapors are being condensed or liquids are being evaporated the distances between the retaining walls may be varied without materially varying the heat conducting efficiency of the apparatus. Where the heat transfer is from the liquid only it is preferable, to secure the greatest efficiency, that the adjacent walls between which it passes be substantially uniform. In my construction I secure this for passages 20 carrying the cooling water as their opposite ends communicate with the comparatively large chambers 22 and 23. In either case as the fluid spaces are comparatively narrow I secure a very rapid and efficient transfer of heat from one medium to the other, and this transfer may be increased as the walls of the tube may be made relatively thin, and the pressures balance each other on opposite sides of the separating walls. This economy in the use of condensing medium reduces the power required for pumping or circulating medium since a smaller amount thereof is required for a given transfer of heat. These narrow fluid spaces also cause rapid cleaning of the surfaces that is, fluid does not cling to the surfaces after being heated or cooled but is kept moving, thus securing a greater and more efficient transfer of heat than would otherwise be the case because fluids are very poor conductors of heat.

A particular advantage of this construction is its safety in operation. It will be noted from an inspection of the drawings that the cell spaces 12 and 13 through which the vapor or gases to be condensed or cooled flow are entirely surrounded by the condensing or cooling medium, in the above example, water. Thus for instance if the device is used for condensing ammonia or other poisonous vapor or an inflammable vapor all leakage thereof will be directly into the condensing or cooling medium, such for instance as water, and will thus be absorbed by the water and carried off with it, thereby making it possible to use this device in practically any location without danger to life or property. Furthermore, all the surfaces of the spaces 20 are easily accessible for cleaning by merely removing the heads.

In Fig. 5, I have shown a slightly different construction where the conduits 24 and 25 are connected to the cells. Here the openings between the conduits and the spaces in the cells are enlarged by recessing the metal wall back somewhat as shown at 33.

Having thus set forth the nature of my invention, what I claim is:

1. In a heat exchange device an outer tubular shell, a plurality of pairs of spaced substantially concentric tubes within the shell and spaced therefrom and providing chambers at the opposite ends of the tubes in communication with the spaces between the tubes of each pair, fluid inlet and outlet connections to said chambers, the adjacent pairs of tubes being inclined with respect to each other so that the spaces between adjacent pairs are wider at one end at the upper side of their longitudinal axes and wider at the other end at the lower side of their longitudinal axes, and inlet and outlet connections to these spaces at substantially the widest portions thereof.

2. In a heat exchange device, an outer tubular shell, a plurality of cells in said shell extending longitudinally thereof and providing chambers at the opposite ends of said cells, each cell being formed by a pair of spaced tubes arranged one within the other and with their opposite ends eccentric in opposite directions, said cells being arranged so that the outer tube of one cell is substantially concentric with the inner tube of the next larger cell to provide annular spaces communicating with said chambers, a fluid inlet connection to the widest portions of the cell spaces at one end, a fluid outlet connection to the widest portions of the cell spaces at the opposite ends thereof, and fluid inlet and outlet connections to the said chambers.

3. In a heat exchange device, a plurality of tubular cells, each cell being formed by a pair of spaced tubes arranged one within the other and with their axes inclined to each other so that their opposite ends are arranged eccentrically in opposite directions, said cells being arranged so that the outer tube of one cell is substantially concentric with the inner tube of the next larger cell to provide annular spaces between them, a fluid inlet connection to the widest portions of the cell spaces at one end, a fluid outlet connection to the widest portions of the cell spaces at their opposite ends, and fluid inlet and outlet connections to the annular spaces.

4. In a heat exchange device, an outer tubular shell, a plurality of cells in said shell extending longitudinally thereof and providing chambers at the opposite ends of said cells, each cell being formed by a pair of spaced tubes arranged one within the other and with their axes inclined to each other so that their opposite ends are arranged eccentrically in opposite directions, said cells being arranged so that the outer tube of one cell is substantially concentric with the inner tube of the next larger cell to provide annular spaces between them communicating with the chambers at the oppo-

site ends of the cells, a fluid connection in each of said chambers extending transversely of the ends of the cells and communicating with the cell spaces at the widest portions thereof and fluid connections to said chambers.

5. In a heat exchange device, a plurality of spaced cylinders of progressively increasing diameter arranged one within the other to provide separated spaces for passage of fluid, a cylindrical casing inclosing said cylinders and of greater length to provide chambers at the opposite ends of said cylinders, the alternate spaces between the cylinders being in communication with said chambers at their opposite ends, and inlet and outlet conduits communicating with the other spaces, said conduits extending transversely across the extreme ends of the cylinders within said chambers with the first mentioned spaces closed from the conduits and with the second mentioned spaces closed from the chambers but opening at their ends into said conduits.

In testimony whereof I affix my signature.

ROBERT L. SHIPMAN.