May 2, 1944. R. H. NORRIS 2,348,020

HEAT EXCHANGER.

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Fig. 1.

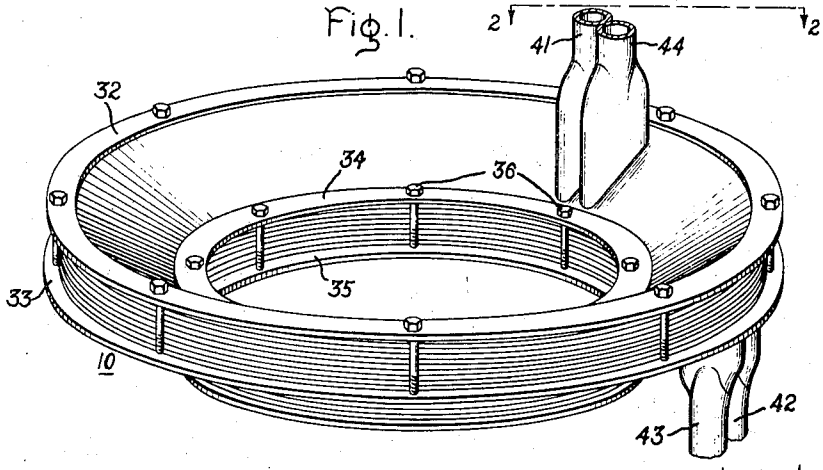


Fig. 3.

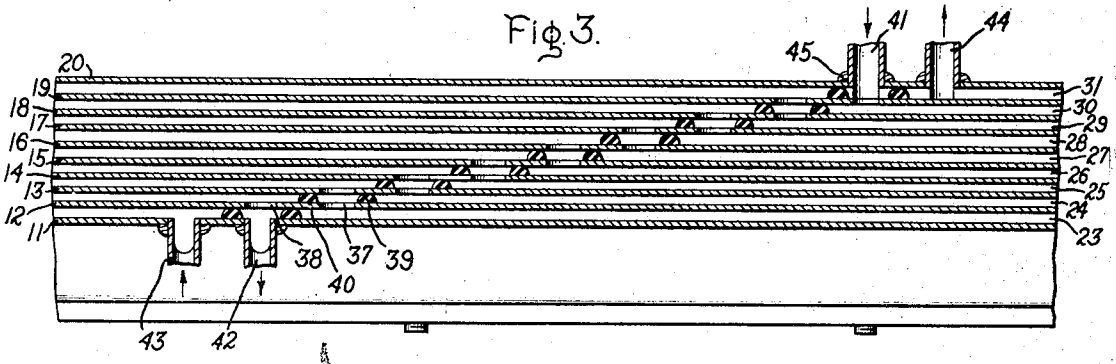


Fig. 2.

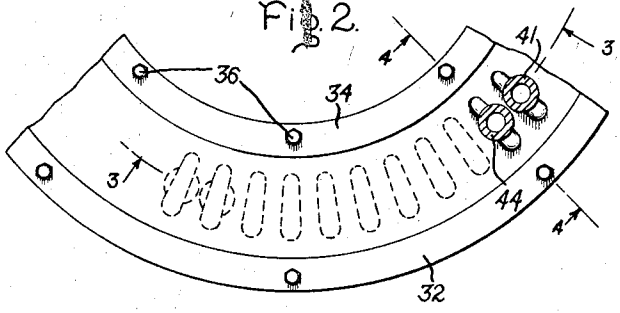


Fig. 5.

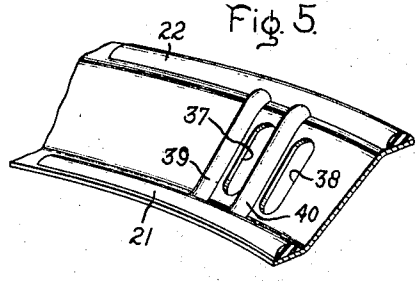


Fig. 4.

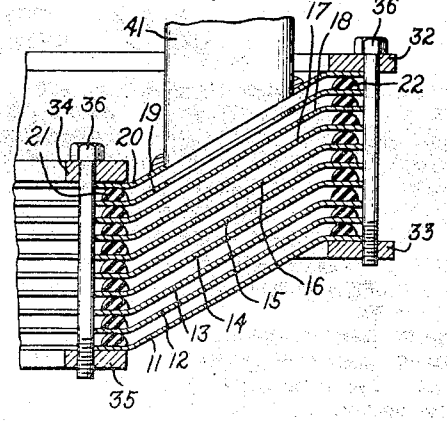
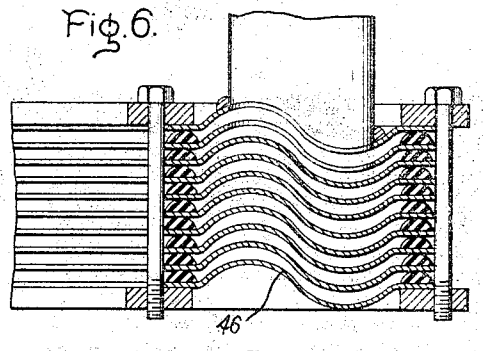


Fig. 6.



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Fig. 7.

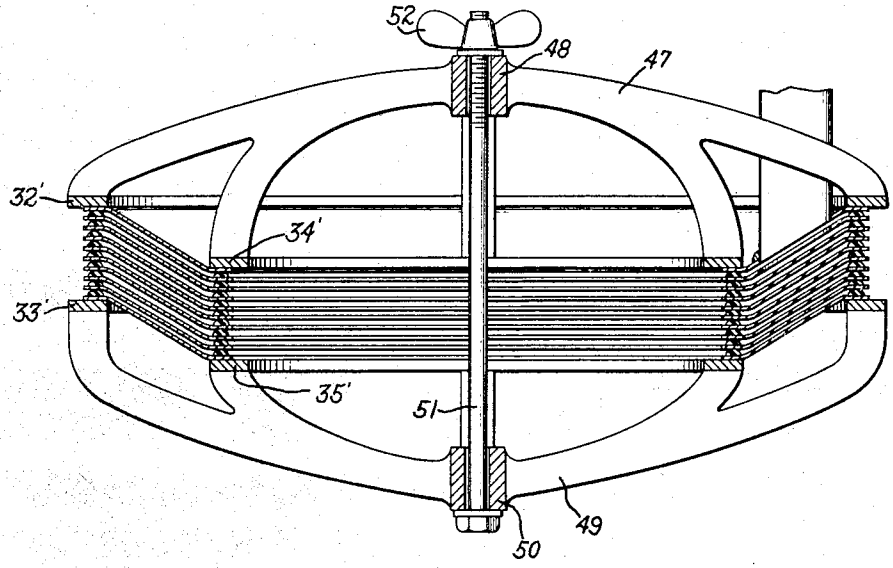
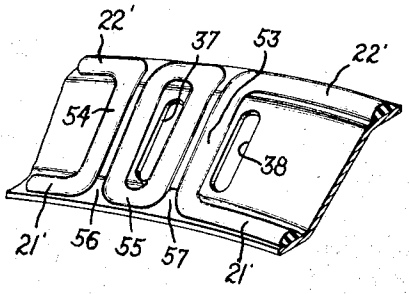


Fig. 8.



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UNITED STATES PATENT OFFICE

2,348,020

HEAT EXCHANGER

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Application April 17, 1941, Serial No. 389,023

4 Claims. (Cl. 257—245)

This invention relates to heat exchange apparatus and more particularly to heat exchange apparatus of the counter flow type and having a plurality of chambers designed to cause liquid to flow in relatively thin layers on opposite sides of relatively thin heat conductive plates and which is especially adapted for the pasteurization of milk.

It is an object of my invention to provide a new and improved heat exchanger, which may be readily assembled and disassembled so that the component parts may be easily cleaned.

It is also an object of my invention to provide a readily assembled and disassembled heat exchanger which is efficient in operation, rugged in construction, and economical of manufacture.

It is still another object of my invention to provide a new and improved heat exchanger assembled from standardized parts so that a heat exchanger of any desired capacity can be formed readily.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention, reference may be had to the accompanying drawings in which Fig. 1 is a view in perspective of a heat exchanger embodying the principles of my invention; Fig. 2 is a plan view of a portion of the heat exchanger shown in Fig. 1 taken in the direction of the arrows 2—2 in Fig. 1 and illustrating the location of the intercommunicating ports; Fig. 3 is an enlarged sectional view of a portion of the heat exchanger shown in Fig. 1 taken along the line 3—3 of Fig 2; Fig. 4 is a cross sectional view of the heat exchanger shown in Figs. 1 to 3, inclusive, taken along the line 4—4 of Fig. 2; Fig. 5 is a perspective view of a portion of one of the annular plates or disks shown in Figs. 1 to 4, inclusive, illustrating the sealing or gasket means associated with the plates; Fig. 6 is a cross sectional view, similar to the view shown in Fig. 4, of a modification of my invention; Fig. 7 is a cross sectional view of a modified form of my invention; and Fig. 8 is a perspective view similar to Fig. 5 showing a modified arrangement of sealing means.

I have provided a heat exchanger comprising a plurality of disks or members in spaced-apart relationship. In the drawings there is illustrated a heat exchanger 10 comprising ten such disks or plates, the disks being indicated by the numerals 11 to 20, inclusive. The annular disks are preferably formed of relatively thin heat conductive material, as sheet metal, so that heat may be readily conducted therethrough to the opposite sides thereof. The relative rigidity of sheet metal is also advantageous in this type of apparatus. Spacing means in the form of annular gaskets disposed adjacent each edge of the disk, as indicated by the numerals 21 and 22, are provided. Thus, the gaskets 21 and 22 in cooperation with the respective plates define adjacent, single and annular fluid conveying chambers or channels 23 to 31, inclusive. The inner and outer circumferences of the chambers or channels defined by the sealing or spacing means have relatively large radii of approximately the same order of magnitude so that the flat conducting chambers or channels between each pair of members are relatively narrow and of substantial length. In order to improve the heat exchange, it is desirable that the fluid to be cooled or to be heated, as milk for example, flow in thin streams. Therefore, the spacing members or gaskets 21 and 22 are dimensioned to provide relatively flat, thin chambers or channels.

I have provided means for providing fluid-tight chambers or channels. In the form of my invention shown in the drawings, this means utilizes gaskets 21 and 22. Thus, the gaskets 21 and 22 may be formed from a sealing material, such as rubber for example, which is sufficiently rigid to provide the necessary spacing between the plate or disk and yet sufficiently soft and resilient to effectively seal the space between the gaskets and the disks. Hollow gaskets may be used, if desired. If preferred, the aforementioned spacing means may take the form of metallic ribs, for example, and the sealing means might then take the form of rubber gaskets disposed circumferentially of the disks. Another alternative would be the use of reinforced rubber gaskets, as for example, by incorporating a wire as a core in a rubber gasket. If desired, instead of using a single gasket between members and affixed to one member, a pair of cooperating gaskets may be used, one on each of the adjacent plates.

In order to increase the strength of the heat exchanger, I have provided means for stiffening the disks or members 11 to 20, inclusive. In the embodiment of my invention shown in Figs. 1 to 5, inclusive, this is accomplished by providing conical or dish-shaped disks, as by a punching operation for example, each disk having an an-

nular flange along each marginal edge, the flanges being disposed in parallel relationship thereby providing surfaces which are especially adapted to cooperate with the sealing or spacing means or both. It will be appreciated that the flanges, being disposed at an angle to the main portion of the disk will also serve to add strength and rigidity to the disk. In the arrangement shown in Fig. 6, the disks are corrugated or S-shaped in the longitudinal direction for the afore-mentioned purpose, as indicated by the numeral 46.

There is also provided suitable means for maintaining the disks in the assembled relationship. In the illustrated form of my invention, this means takes the form of a pair of annular members 32 and 33 engaging the stack at the outer edge thereof and a second pair of annular members 34 and 35 engaging the stack at the inner edge thereof, suitable fastening means as bolts 36 being extended through suitable openings in the upper annular members into threaded engagement with suitably tapped bores in the other annular rings for drawing the disks together. Any other suitable fastening or clamping means may be employed.

The heat exchanger illustrated in the drawings is arranged for the circulation of two fluids in heat exchange relationship, a fluid to be cooled or heated and a second fluid to perform necessary heat exchange. For example, in the pasteurization of milk, steam may be used to supply heat to the milk or in a milk cooler, for example, a cooling fluid as water may be employed to cool down heated milk. I have arranged my heat exchanger so that the fluids flow in alternate layers or channels through the stack so that milk, for example, will flow through a channel extending between two steam or hot water passages or channels. To this end, the disks 11 to 20, inclusive, are arranged in such a way that when assembled there are provided two sets of serially-connected fluid conveying channels, a channel from either set being disposed between channels of the other set. In order to increase the efficiency of the arrangement, the disks are so disposed that the fluids flow in counter flow whereby the effective mean temperature difference between the flowing streams is increased inasmuch as the temperature between adjacent streams is more uniform than if both streams flowed in the same direction on both sides of the plates.

In order to accomplish these results, I have provided two circumferentially spaced-apart ports 37 and 38 in each disk, the ports extending transversely of the disk, that is, radially. There are provided transversely extending gaskets or sealing members 39 and 40 extending between the circumferential sealing members or gaskets 21 and 22 on each side of one of the ports, as 37 for example, thereby isolating the port 37 from the passage or channel associated with that particular disk or plate. This arrangement is best seen in Fig. 5.

In assembling my heat exchanger, the plates are stacked up one above another with the isolated or walled port 37 in registry or alignment with the non-isolated port 38 in the next adjacent disk. In other words, each disk is displaced in a circumferential direction, as counterclockwise in the drawings, the distance between ports with respect to the adjacent disk, one part in each disk being aligned. Thus, the isolated or walled port 37 of plate 14, for example, corresponds or is aligned with the non-isolated port 38 of disk 15. Thus the fluid flowing through chamber 25 will flow through the slot 37 not into the chamber 26 but on through the slot 38 in plate 15 into the chamber 27. In other words, the isolated ports serve to provide through passage through the plate in which the isolated port is located and the sealing members or gasket 39 and 40 serve as end walls for the associated chamber or channel.

By making all of the disks identical or duplicate, it is very simple to assemble any number of disks in a stack. Thus, a very simple means is provided for varying the capacity of the heat exchanger. Since the ports are located in the same position in each disk, the proper location of ports in successive plates is obtained merely by rotating each successive plate or disk with respect to the previous disk.

In order to conduct fluids to and from the heat exchanger, there is provided a suitable inlet conduit 41 and an outlet conduit 42 for one fluid and an intake conduit 43 and an outlet conduit 44 for the second fluid. The conduits 41 to 44, inclusive, may be suitably fastened in cooperation with the slots in the top and bottom plates or disks 11 and 20, respectively, in any suitable manner, as by welding as indicated by the numeral 45, for example.

In operation, in a milk pasteurizer, for example, the milk to be pasteurized will enter the exchanger through the inlet conduit 41, pass through plates 20 and 19 into the chamber 30, thence around the chamber 30 to the right or in a counter clockwise direction, downwardly through plates 18 and 17 into chamber 28 and so on until finally the milk will flow from chamber 24 downwardly through plates 12 and 11 into outlet conduit 42. The heating medium, as steam for example, will enter the heat exchanger through the inlet conduit 43 and pass to the left or in a clockwise direction through the chamber 23, upwardly through the aligned port in plates 12 and 13 into chamber 25 and so on until finally the heating medium will pass out of the heat exchanger from chamber 31 and conduit 44.

In order to prevent regions of stagnant flow in corners, near the inlet and outlet ports and conduits or ducts, the ports and conduits are made substantially as wide as the channels themselves, and if desired, the gaskets or separating means 21, 22, 39 and 40 may be shaped so that there are no sharp corners. The conduits 41 to 42, inclusive, may be in the form of flat tubes but in the illustrated form of my invention, I have shown round conduits flattened out in the vicinity of the heat exchanger.

The aforementioned heat exchanger is advantageous because the fluid conveying chambers or channels are provided with smooth surfaces thereby rendering the heat exchanger easy to clean. Furthermore, by providing narrow channels, it is unnecessary to provide ribs or the like to direct the streams of fluid through the exchanger and therefore there is nothing in the arrangement to cause the separation of cream and skimmed milk, nor are there any ribs or corrugations to accumulate casein deposits. Further, since the fluid paths curve gradually at all times, there is inherently a moderate turbulence of the flowing fluid which helps to maintain a uniform velocity over the cross section of the milk stream and a uniform turbulence which results in improved heat transfer characteristics but no great increase in resistance to flow.

In Fig. 7, there is illustrated an alternative securing means for maintaining the stacked heat exchangers in assembled relation which permits unusually rapid assembly or disassembly. I employ a plurality of rings or annular members 32' and 33' engaging the outer edges and members 34' and 35' engaging the inner edges of the annular stacks in the same manner as rings 32 to 35 inclusive in the arrangement illustrated in Fig. 1. Rings 32' and 34' are maintained in the stack engaging positions by means of a spider 47 comprising a plurality of legs engaging the rings and having a central boss 48 provided with an axially extending bore. Similarly, rings 33' and 35' are maintained in the desired positions by a spider 49 having a boss 50 centrally arranged and having an axial opening therethrough in alignment with the axial opening in boss 48. The assembly is maintained in the assembled condition by a suitable fastening means as a bolt 51 extending through the aligned bores and the central portion of the stack and a wing nut 52.

In Fig. 8, there is illustrated an alternative means for isolating the transfer port 37 and sealing the fluid conveying chambers associated with the non-isolated port 38. Instead of providing complete annular seals 21 and 22, as shown in Fig. 5, and transverse gaskets 39 and 40 for defining fluid conveying chambers, I have provided substantially annular members 21' and 22' joined at the ends thereof by transverse portions 53 and 54. The port 37 is isolated by sealing means 55 extending entirely around the port. This arrangement provides passages 56 and 57 communicating between each pair of disks or members and the atmosphere for conducting any leakage past the gaskets or seals out of the exchanger.

While I have illustrated a horizontally arranged heat exchanger, the assembly may be disposed in any desired position, horizontally or otherwise.

While I have shown a particular embodiment of my invention, I do not desire my invention to be limited to the particular construction shown and described and I intend in the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A heat exchanger comprising a plurality of conically-shaped, duplicate annular disks arranged in nested relationship, each of said disks having an annular flange adjacent each marginal edge thereof, each of said disks having means adjacent each marginal edge and cooperating with the adjacent disk for spacing apart said disks in order to provide a relatively flat, narrow fluid conducting channel, means for rendering said channels fluid-tight, means for maintaining said disks in assembled relationship, each of said disks having a pair of spaced apart ports, said disks being assembled so that each disk is displaced in a circumferential direction the distance between said ports with respect to the adjacent disks, a port in each disk being aligned with a port in the adjacent disk, sealing means disposed about one of said ports for isolating said one of said ports, the isolated port in one disk being aligned with the non-isolated port in the adjacent disk whereby two sets of series connected fluid conveying channels are provided, a channel from either set being disposed between channels of the other set so that two fluids may be conducted through said heat exchanger in counter-flow.

2. A heat exchanger comprising a plurality of duplicate annular members arranged in nested relationship, each of said members having an annular flange adjacent each marginal edge thereof, each of said members having means adjacent each marginal edge and co-operating with the adjacent member for spacing apart said members in order to provide a relatively thin and narrow fluid conducting channel, means for rendering said channel fluid-tight, means for maintaining said members in assembled relationship, each of said members having a pair of spaced apart ports, said members being assembled so that each member is displaced in a circumferential direction the distance between said ports with respect to the adjacent members, a port in each member being aligned with a port in the adjacent member, sealing means disposed about one of said ports for isolating said one of said ports, the isolated port in one member being aligned with the non-isolated port in the adjacent member whereby two sets of series-connected fluid conveying channels are provided, a channel from either set being disposed between channels of the other set so that two fluids may be conducted through said heat exchanger in counter-flow.

3. A heat exchanger comprising a plurality of duplicate annular members of substantial radius, the inner and outer circumferential edges thereof having relatively large radii of approximately the same order of magnitude, means for defining a single, annular, relatively thin and narrow fluid conducting chamber between each pair of adjacent members of substantially uniform width, said means spacing apart said members and also rendering fluid-tight said chambers, each of said members having two circumferentially spaced-apart ports, sealing means for isolating one of said ports, said members being assembled so that each member is displaced in a circumferential direction the distance between said ports with respect to the adjacent members whereby said isolated port is aligned with the non-isolated port in one of the adjacent members.

4. A heat exchanger comprising a plurality of duplicate annular members of S-shaped cross section and arranged in nested relationship, each of said members having an annular flange adjacent each marginal edge thereof, each of said members having means adjacent each marginal edge and cooperating with the adjacent member for spacing apart said members in order to provide a relatively narrow fluid-conducting channel, means for rendering said channels fluid-tight, means for maintaining said members in assembled relationship, each of said members having a pair of spaced apart ports, said members being assembled so that each member is displaced in a circumferential direction the distance between said ports with respect to the adjacent members, a port in each member being aligned with a port in the adjacent member, sealing means disposed about one of said ports for isolating said one of said ports, the isolated port in one member being aligned with the non-isolated port in the adjacent member whereby two sets of series connected fluid conveying channels are provided, a channel from either set being disposed between channels of the other set so that two fluids may be conducted through said heat exchanger in counter-flow.

ROLLIN H. NORRIS.