April 15, 1930. A. D. HARRISON 1,754,857

HEAT EXCHANGE APPARATUS

Filed April 10, 1929 3 Sheets-Sheet 1

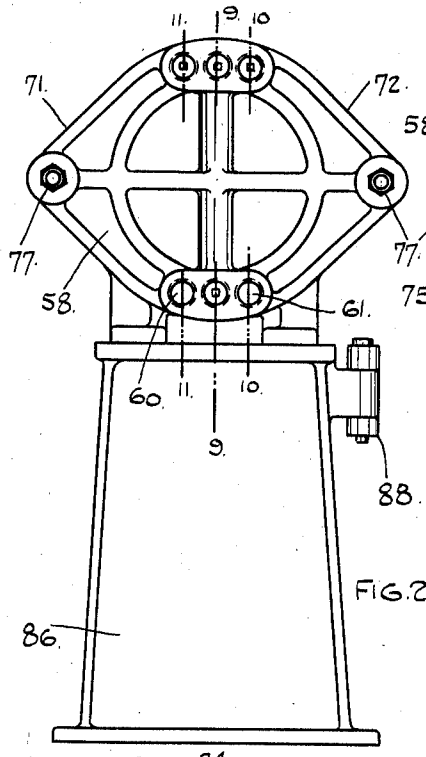


FIG. 2.

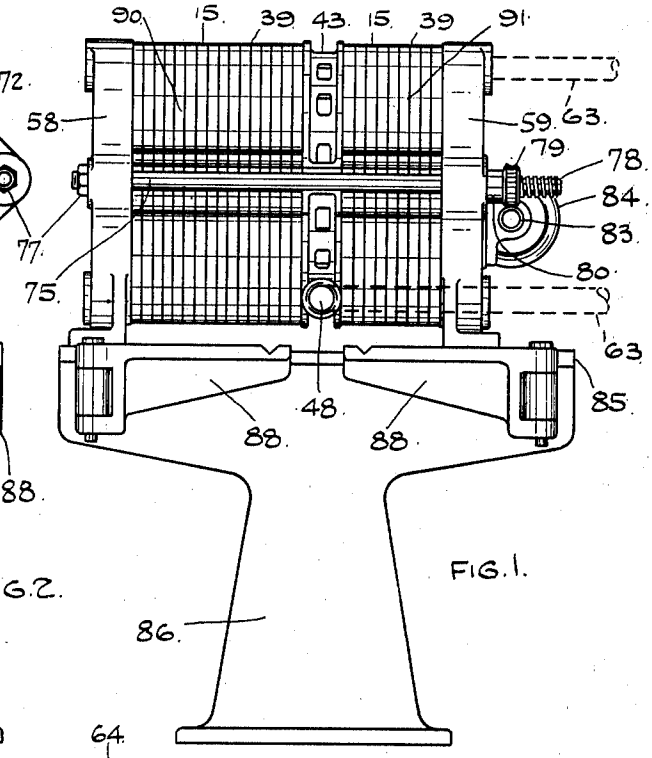


FIG. 1.

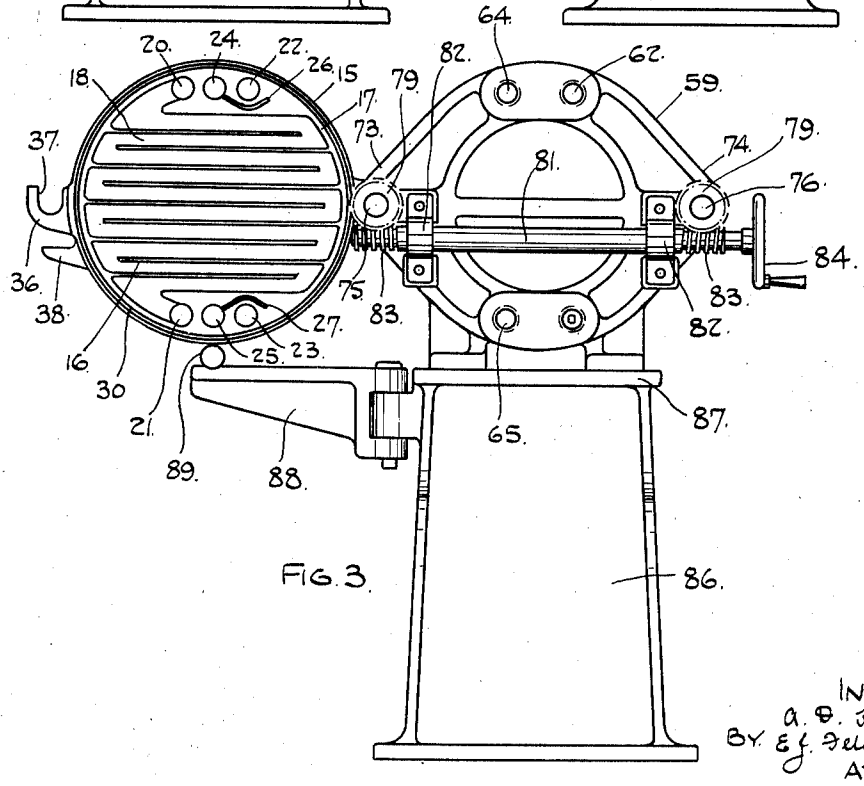


FIG. 3.

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HEAT EXCHANGE APPARATUS

Filed April 10, 1929 3 Sheets-Sheet 2

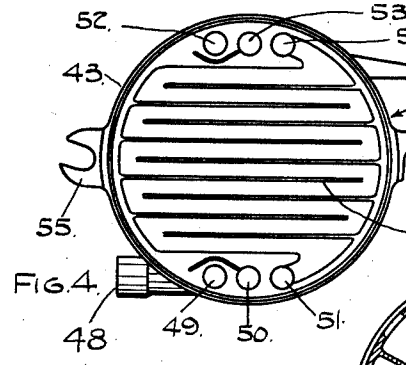


FIG. 4.

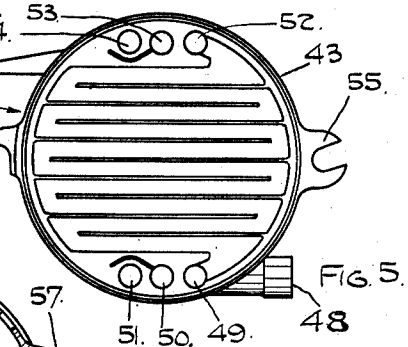


FIG. 5.

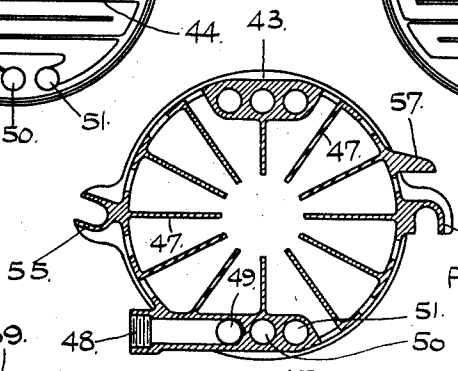


FIG. 6.

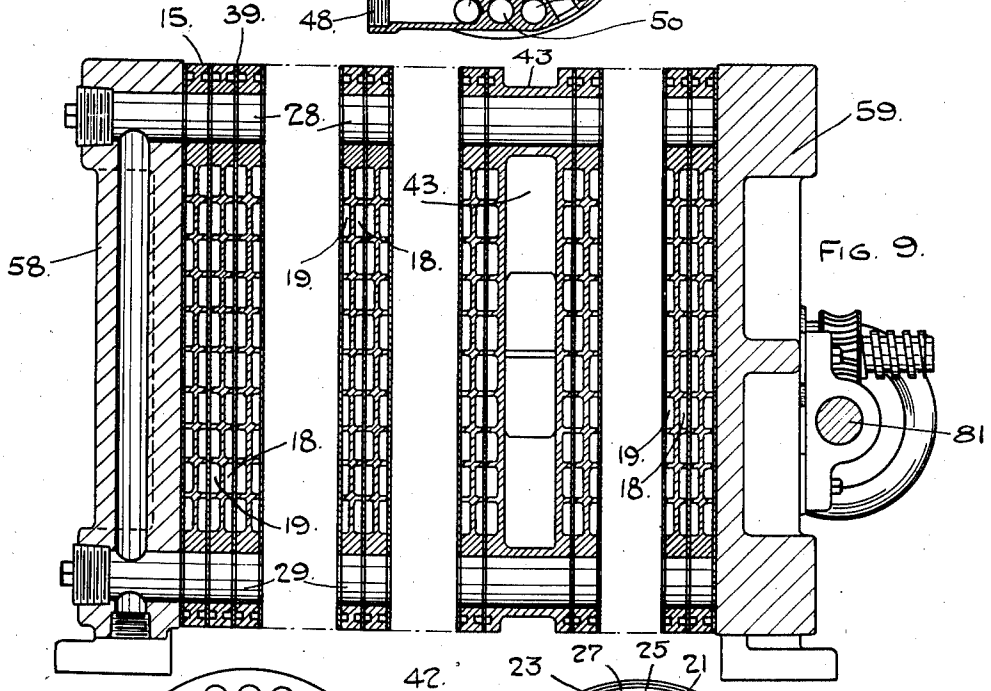


FIG. 9.

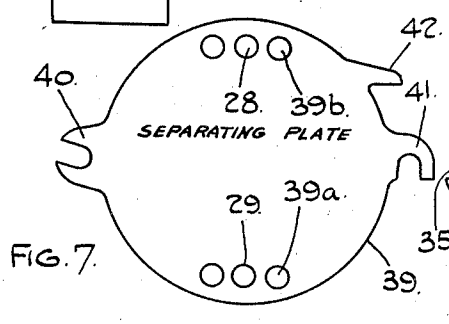


FIG. 7.

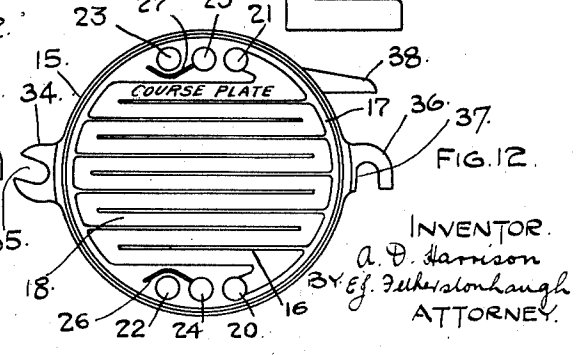


FIG. 12.

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HEAT EXCHANGE APPARATUS

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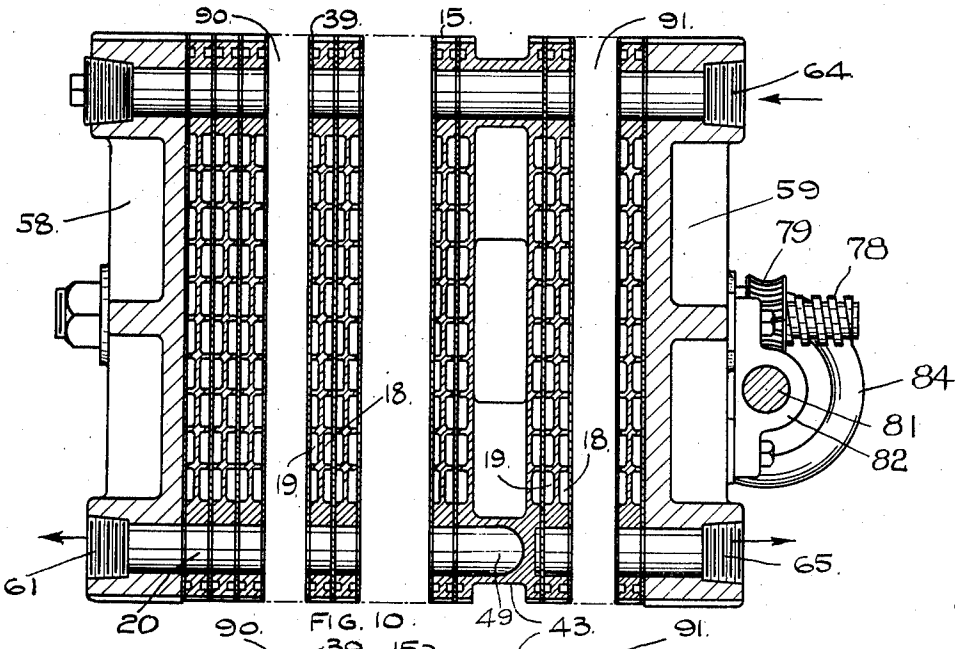


FIG. 10.

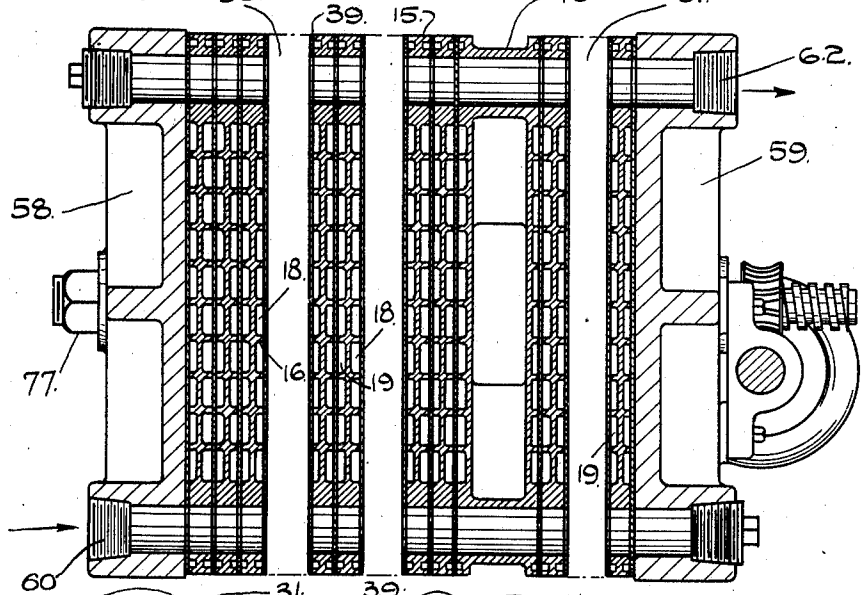


FIG. 11.

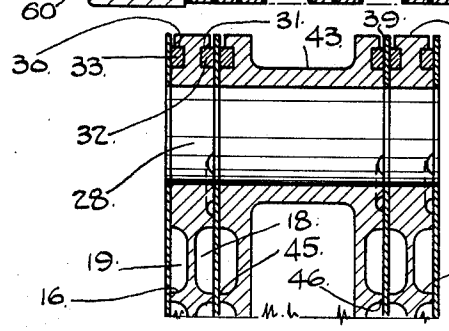


FIG. 8.

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Patented Apr. 15, 1930 1,754,857

UNITED STATES PATENT OFFICE

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HEAT-EXCHANGE APPARATUS

Application filed April 10, 1929. Serial No. 354,115.

The invention relates to heat exchange apparatus, as described in the present specification and illustrated in the accompanying drawings that form part of the same.

The invention consists essentially of the novel features of construction pointed out broadly and specifically in the claims for novelty following a description containing an explanation in detail of an acceptable form of the invention.

The objects of the invention are to promote the flow of the liquid or liquids through the apparatus, so that the exchange of temperature from one liquid to the other will be accomplished rapidly and evenly throughout the machine; to conduct the flow across each plate in a continuous stream from port to port at the ends of the tortuous courses; to facilitate the cleaning of the plates, and thereby insure sanitary measures particularly in the pasturization of milk; to furnish a machine adaptable to many processes in the exchange of liquid temperatures and in which heat may be utilized to the best advantage; to economize in so far as the cost of production is concerned by facilitating the machining of the parts and to effect in the assembly of these parts the elimination of leakage, in so far as it is possible to do so, and the provision for drainage in the event of any leak occurring; and generally to provide in such devices, efficiency, serviceability and durability.

In the drawings, Figure 1 is a side elevational view of the machine.

Figure 2 is an end elevational view of the machine.

Figure 3 is a front elevational view of the machine showing a plate swung over for cleaning purposes.

Figure 4 is an elevational view, showing one face of a divisional plate.

Figure 5 is an elevational view, showing the other face of the divisional plate.

Figure 6 is a vertical sectional view of the divisional plate.

Figure 7 is an elevational view of a separating plain faced plate.

Figure 8 is a fragmentary sectional detail, showing the divisional plate assembled with double faced ribbed plates and plain faced separating plates.

Figure 9 is a longitudinal sectional view one the line 9—9 in Figure 2.

Figure 10 is a longitudinal sectional view on the line 10—10 in Figure 2.

Figure 11 is a longitudinal sectional view on the line 11—11 in Figure 2.

Figure 12 is a detail of a course plate.

Like numerals of reference indicate corresponding parts in the various figures.

Referring to the drawings, the machine is shown as formed of a number of ribbed plates separated by plain plates and divided in groups by a divisional plate, where the feed of liquid is regulated through the groups. These plates are for cellular courses, in which the liquids flow for the exchange of heat from one side of a ribbed plate to the other.

To clearly understand the application of this invention, Figure 1 may be used as an example of a machine constructed in accordance therewith, in which the machine is divided into two parts, 90 and 91 separated by a divisional plate 43 for use in the heating and cooling of milk in the process known as pasturization of milk.

The cold raw milk entering the fixed header through the port 60 (in Figures 2 and 11) passes completely through the machine in a manner to be described later, leaving the port 62 (in Figure 11) from which it is passed to tanks where it is held for a period of time necessary to the pasturizing process.

Upon leaving the tanks the milk is returned to the machine entering at port 48 (in Figures 1 and 6) and flows through the passages on the reverse side of the plates to that of the incoming raw milk being heated and leaves at 61. The hot milk from the holding tanks is therefore caused to heat the cold milk going to the holding tanks and a transfer of heat takes place. Section 90 is therefore called a regenerator.

The flow through section 90 in this example is designed for each fluid to flow twice across the plates. To accomplish this the raw milk entering the port 60 is met half way through the section 90 by the blank surface of a special plain plate 39, (the regular plain plate 39

is shown in Figure 7), in which a hole 39[a] is omitted, and the milk is therefore caused to flow upwards through the first half of section 90 from which it passes to the second half through a hole 39[b] in the special plate.

The flow of the incoming milk in the second half of section 90 is downwards and after passing through the hole 51 in the divisional plate flows upwards through section 91 to reach the outlet 62.

The milk returning from the tanks and entering the machine at the port 48 has the same flow as the raw milk but in the opposite direction and on the opposite sides of the plates.

The milk passing upwards in section 91 is heated by hot water or steam flowing downwards on the opposite sides of the course plates, the hot water or steam entering at port 64 and leaving at port 65.

The milk leaving at port 61 being partially cooled by the incoming milk is further cooled in passing through a similar machine by means of cold water and brine.

The above example is typical of the uses to which this invention can be applied, but in no way restricts its application thereto.

The double faced ribbed plates, Figures 3 and 12, may here be termed course plates for convenience in description and are indicated by the numeral 15 and are each formed on either side with the ribs 16 extending from each side alternately of the surface finished circular flanges 17 to form the tortuous course 18, on the one side of the plate and the tortuous course 19 on the other side of the plate.

The course 18 terminates at one end in the port 20 within a flange 17 and at the other end in the port 21 also within a flange 17, the course 19 terminating at one end in the port 22 within a flange 17 and at the other end terminating in the port 23 also within a flange 17, the drainage port 24 being grouped with the ports 20 and 22 within a flange 17, and the drainage port 25 being grouped with the ports 21 and 23 within a flange 17, and having the drainage channels 26 and 27, directing any leakage into the passages 28 and 29 which are formed by the drainage ports 24 and 25 respectively.

The packing grooves 30 and 31 in the flanges 17 encircle the courses 18 and 19 and the ports 20, 22 and 24 at the top of Figure 3, and the ports 21, 23 and 25 at the bottom of Figure 3, that is to say, all the ports and all the courses outlined by the ribs are enclosed within the single boundaries, one on either side of the plate, and these grooves are made in the surface finished faces of the flanges and contain the packing rings 32 and 33 respectively as shown in Figure 8.

The slotted lug 34 extends from one side of the course plate 15 having the oblique shaft slot 35 and the slotted lug 36 extends from the other side diametrically opposite to the slotted lug 34 and is slotted at 37 to form the lug into crook shape, so as to rest the plate on the shaft at the opposite side of the machine to the shaft lug 34 as will be more fully explained hereinafter.

The lug 38 also extends out from the side of the plate 15 immediately above the crooked lug 36 and is used for the purpose of swinging the plate inwardly and outwardly.

The plain faced separating plates 39 are introduced between the course plates 15 and are formed with corresponding lugs 40 and 41 respectively, the lug 40 corresponding to the lug 34 and the lug 41 corresponding to the lug 36, while the handle lug 42 corresponds to the lug 38.

These plates 39 are introduced between the plates 15 so that the surface finished faces of the ribs 16 of the one plate meet the plain faces of the plates 39 to form the liquid tortuous courses and the surface finished faces of the flange 17 meet the plain faces of the plates 39, the packing being introduced in the grooves of the course plate as aforesaid, and coming into contact with the surfaces of the plates 39, so as to avoid any leakage of the fluid from between the course plates and plain plates. The grooves 26 and 27 on the course plate will take care of leakages between the courses and the ports by directing the flow to the drainage passages 28 and 29.

The divisional plate 43 is formed with exactly the same formation of ribs 44 as the ribs 16, on either side, that is to say, the divisional plate 43 is considerably thicker than the plates 15, so that its ribbed faces 45 and 46 are spaced by the webs 47, and this is for the purpose of providing an inlet 48 into which the liquid enters to one set of courses.

This inlet 48 connecting with the port 49 is grouped with the drainage port 50 and the port 51. The port 49 in the divisional plate forms the inlet end of the passage formed by the ports 22 in the course plates 15.

The ports at the upper end of the divisional plates correspond to these lower ports, 52 acting with the port 49 the port 53 corresponding to the drainage port 50 and the port 54 acting with the port 51.

The slotted lug 55 from one side of the divisional plate corresponds to the slotted lug 34, the crooked lug 56 on the other side corresponding to the crooked lug 36 and the lug 57 corresponding to the lug 38.

The divisional plate 43 separates the assembled ribbed plates 15 and plain plates 39 into groups, that is to say, it divides the assemblage, and all of these plates are contained within the fixed header 58 and the sliding header 59.

The fixed header 58 is formed with the liquid inlet 60 and the liquid outlet 61, and the sliding header is provided with the outlet 62.

The heating fluid inlet 64 as well as the

heating fluid outlet 65 are through the sliding heater 59 and these are connected to a hot water supply or other heating liquid.

The inlet 60 through the fixed header 58 is connected to a supply of liquid to be heated, and the outlet 62 is the discharge for the heated liquid.

The fixed header 58 is extended to form the wings 71 and 72, while the sliding header 59 is extended to form the wings 73 and 74, the wing 71 being connected with the wing 74, by the shaft 76, while the wing 72 is connected to the wing 73 by the shaft 75.

The shafts 75 and 76 are formed at the one end with the heads 77, which engage the fixed header 58 while the said shafts at the other end, where they project through the sliding header 59 are threaded as shown at 78.

The worm wheels 79 extend from the hubs 80 and these hubs engage the face of the sliding header 59 the said worm wheels being threaded and screwed on to the threaded ends of the shafts 75 and 76.

The transverse shaft 81 is journalled in the bearings 82 secured to the sliding header 59. This shaft is formed with the worms 83, one at either end, coacting with the worm wheels, 79, therefore by operating the crank handle 84, the worm wheels are screwed inwardly and outwardly on the shafts 75 and 76 in order to clamp the plates 15, 39 and 43 securely between the headers 58 and 59.

The header 58 is rigidly secured at one end of the table 85 and this table is supported on the pedestal 86 and carries a sliding way 87 for the header 59.

The brackets 88 extend outwardly from one side of the pedestal 86, and table 85, there being a bracket at each end. The brackets 88 support the rail 89 and this rail forms a support for one or more of the plates swung outwardly for cleansing purposes.

In the operation of this machine, the plates 15, the plates 39, and the plate 43, are assembled between the headers 58 and 59 as shown, there being a collection of plates indicated by the numeral 91 on one side of the divisional plate and a larger collection, indicated by the numeral 90 on the other side of the divisional plate, the larger collection being divided into groups by blocking communicating ports in the separating plates at the end plate of a group, thus insuring a predetermined number of parallel flows upwardly and downwardly alternately in each group.

The lugs 34 are mounted on the shaft 75, also the lugs 40 and the lugs 55 therefore these plates are loosely hinged on the said shaft 75 and are swung over to the shaft 76 the crooked lug 36 of the course plates engaging the shaft 76, also the lug 41 of the separating plates and also the lug 56 of the divisional plate.

With the plates in this position the crank handle 84 is turned, which clamps the plates very tightly together and compresses the various packing rings, so that the cellular nature of the plates is very much in evidence, and these many ribbed plates constitute the groups of parallel courses such courses being tortuous.

What I claim is:—

1. In heat exchange apparatus, a plurality of course plates alternating with plain separating plates and forming parallel courses and having ports within the circumference of the plate forming passages for said parallel courses across plate groups on respective sides of the course plates.

2. In heat exchange apparatus, a plurality of ribbed plates between headers separated by plain faced plates and having packing grooves forming boundaries enclosing the streams of parallel courses outlined by said ribs and the communicating groups of flow ports and leakage holes in contiguous arrangement in the lines of the courses and packing in said grooves.

3. In heat exchange apparatus, a plurality of ribbed plates containing courses and plain separating plates and communicating ports and passages between the two sides of the ribbed plates respectively for fluids of different temperatures one set of ports connecting one set of passages in groups and another set of ports connecting the other set of passages in groups and drainage ports included with the aforesaid ports and courses within the boundary formed by packing rings.

4. In heat exchange apparatus, a plurality of plain faced plates, a plurality of plates separated by said plain plates having ribbed surfaces forming tortuous courses across each plate on both faces and holes in the plates connecting the corresponding courses of the plates and holes grouped with the aforesaid holes and therebetween and forming drain passages connected with slots in the faces of the plates, each plate having a packing groove on either side bounding said courses and said holes, and packing in said grooves.

5. In heat exchange apparatus, a plurality of plates having ribs outlining tortuous courses, separating plates having plain faces, said ribbed plates at the terminii of each course and in the line of flow having ports connecting alternate courses and also having surface finished faces meeting a separating plate and suitably packed beyond said courses and ports.

6. In heat exchange apparatus, a plurality of circular ribbed plates and a plurality of plain plates together forming tortuous parallel courses and having connecting ports and drainage passages in groups at the upper and lower ends and within the circumference of the plates.

7. In heat exchange apparatus, a frame, a fixed header secured to said frame, a slidable header mounted on said frame and a plurality

of contiguous plates between said headers and clamped by the sliding and locking of the slidable header.

8. In heat exchange apparatus, a frame, sliding and fixed headers mounted thereon, shafts mounted in said headers contiguous plates forming liquid courses and having lugs engaging said shafts and means for engaging said shafts to clamp said plates to their assembled position.

9. In heat exchange apparatus, sliding and fixed headers suitably supported and extending transversely and having shaft orifices, shafts secured in said fixed header and having threaded ends projecting through said sliding header, contiguous plates forming liquid courses between headers and having lugs therefrom engaging said shafts and forming hinge and clasp members, worm wheels engaging said sliding header and threaded on said shaft ends, a worm shaft coacting with said wheels and journalled in bearings from said sliding header and a crank handle secured to said worm shaft.

10. In heat exchange apparatus, a plurality of contiguous plates forming liquid courses and having slotted and crooked lugs, headers and parallel shafts forming a support for said plates, mechanism for clamping said plates between said headers, said mechanism comprising screw threads on said shafts, nuts, and worm gears and brackets having a rail thereon forming a support for one or more of said plates when swung to the open position.

Signed at Montreal, Canada, this 28th day of March, 1929.

ALBERT DEX HARRISON.