

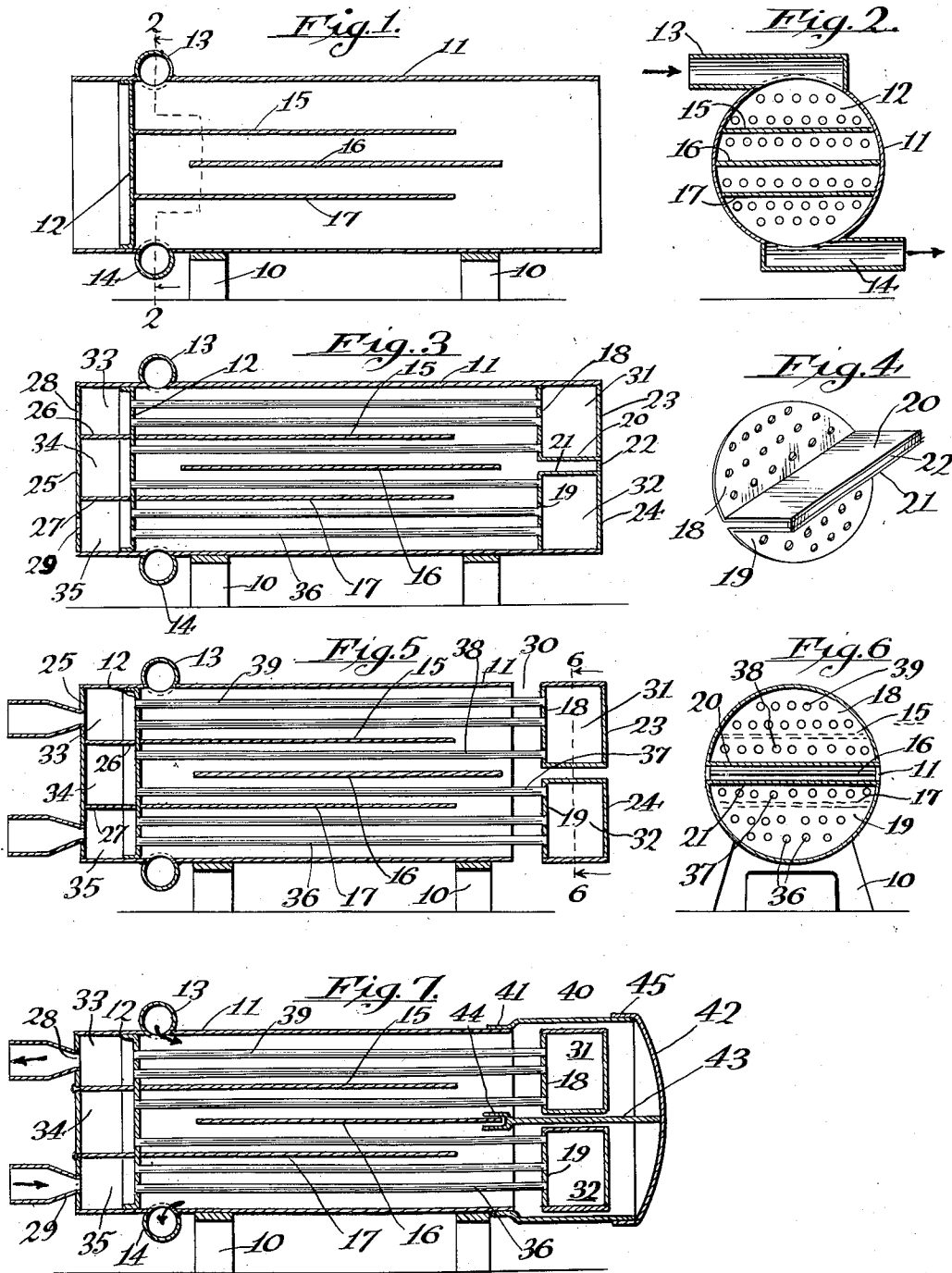
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HEAT EXCHANGER

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HEAT EXCHANGER.

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This invention relates to improvements in heat exchangers, preheaters, dephlegmators and the like, and also to a method of constructing the same.

5 An object of this invention is to provide an improved device of the above mentioned character, wherein the tubes which define the tortuous or winding passage within the shell each have one end connected to a stationary
10 part and the other end movable, permitting each bank of tubes to expand and contract independently of each other because of variations in temperature and without in any way tending to warp the shell or to develop
15 stresses therein, which might produce leakage.

Another object of this invention is to provide a device having the above mentioned qualities, wherein heat is to be transferred from one flowing fluid to another flowing fluid and which employs a true counterflow principle.

A further object of this invention consists in providing an improved method for constructing a novel heat exchanger or the like to permit the various necessary tests to be made during the construction.

With the foregoing and other objects in view which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

35 Figure 1 is a vertical section through the improved device, showing it in its preliminary state of construction,

Fig. 2 is a vertical section taken on the line 2-2 of Fig. 1,

40 Fig. 3 is a vertical section through the improved device, illustrating it during a more advanced stage of construction,

Fig. 4 is a perspective view illustrating the sections of the movable tube sheet before being applied to the device,

45 Fig. 5 is a vertical section through the device in a still further advanced stage of construction,

Fig. 6 is a vertical section taken on the
50 line 6-6 of Fig. 5, and

Fig. 7 is a vertical section through the improved heat exchanger in its completed form.

Referring to the accompanying drawings

wherein similar reference characters designate similar parts throughout, the improved device is constructed in the following manner: There are provided suitable supports 10, on which is positioned a cylindrical shell 11. Within this shell adjacent one end there
55 is rigidly secured a stationary tube sheet 12. Adjacent this tube sheet and at the top and bottom of the shell there are formed openings to which are welded pipe sections 13 and 14 which provide an inlet and an outlet
60 to the shell. Three baffles are arranged in the shell, these being indicated at 15, 16 and 17. The three baffles have their side edges welded to the interior of the shell throughout their complete length, and the top and
65 bottom baffles 15 and 17 extend from the stationary tube sheet 12 rearwardly while the middle baffle 16 has its forward end spaced somewhat from the stationary tube sheet. After this construction has been ap-
70 plied to the shell, a movable tube sheet is positioned in the rear end of the shell. This movable tube sheet is shown as consisting of two semi-circular sections 18 and 19. They are provided with plates 20 and 21 which
75 extend from the diametrical edges of the semi-circular sections 18 and 19 rearwardly. The sections of the movable tube sheet have their edges welded to the shell and the tubes are positioned therein, the arrangement of
80 which will be hereinafter more fully described. On the application of the movable tube sheet sections, the side edges of the plates 20 and 21 are welded to the interior of the shell, and the rear edges of the plates 20 and 21 are welded to each other, as indicated by the weld 22.

With this much of the construction completed, fluid pressure is applied to the interior of the shell through the inlet and outlet
85 13 and 14, this fluid pressure serving to indicate or disclose any leaks which may be present in the seams or joints between the tube sheet sections and the shell or around the ends of the tubes. If there are any leaks
90 present, these are immediately repaired, and when this has been done, two semi-circular head sections 23 and 24 are applied having their arcuate edges welded to the shell 11 and having their diametrical edges welded
95 to the rear edges of the plates 20 and 21. At the same time the weld 22 is cut out, leaving the plates 20 and 21 unconnected to each
100 105

other except by the shell 11. In this stage of the construction a forward head 25 is applied, and two partitions 26 and 27 are also applied. These partitions are welded to the interior of the shell and to the stationary tube sheet 12, and they are also welded to the back of the forward head 25, such welding being done through the openings 28 and 29 formed in the head 25. A portion of the shell 11 immediately forward of the sections 18 and 19 of the movable tube sheet is then cut away, as indicated at 30 upon Fig. 5. At the same time that this portion of the shell is cut away, the shell is cut between the plates 20 and 21, as clearly shown upon Fig. 6. When the device has reached this stage of construction it has the following characteristics: The two divided portions of the shell together with the sections 18 and 19 of the movable tube sheet and the sections 23 and 24 of the movable head and the plates 20 and 21 form two chambers 31 and 32. In a similar manner at the forward end of the shell, the head 25 together with the stationary tube sheet 12 and the two partitions 26 and 27 form three stationary chambers 33, 34 and 35.

The arrangement of the tubes may now be described. Below the bottom baffle 17 there is a set of tubes 36 which connect the chamber 35 with the movable chamber 32. Immediately above the bottom baffle 17 there are other tubes 37 which connect the top of the movable chamber 32 with the stationary chamber 34. These tubes are located immediately below the middle baffle 16. Between the middle baffle 16 and the top baffle 15 there are tubes 38 which connect the top of the stationary chamber 34 with the bottom of the movable chamber 31, and between the top baffle 15 and the top of the shell tubes 39 connect the movable chamber 31 with the stationary chamber 33. In this manner the tubes together with the chambers form a continuous winding or tortuous passage within the shell, the inlet of which may be considered as being the aperture 29 and the outlet being considered as being provided by the aperture 28 formed in the head 25.

At this state of construction another test is made, applying pressure through the apertures 28 and 29 to disclose any leaks which may be present in the movable chambers 31 and 32, and also which may be present about the stationary chambers 33, 34 and 35. If no leaks are present, or when the leaks are repaired, the heat exchanger is then in condition to be completed.

A shell segment 40 is then slipped onto the shell, this being possible for the reason that this shell segment is of a slightly greater diameter than the diameter of the shell 11. It has its forward end welded to the rear edge of this shell, as indicated at 41, and a

rear head 42 for the shell is then applied. This rear head carries with it a baffle plate section 43 having a bifurcated forward end 44, this bifurcated end being capable of passing between the plates 20 and 21 which form walls of the movable chambers 31 and 32. If the plates 20 and 21 are too close together, the chambers can be sprung apart slightly to permit the bifurcated end 44 to be passed between them. The bifurcated end 44 forms a type of slip joint between the baffle plate section 43 and the middle baffle 16. The head 42 is fastened to the shell segment 40 by welding which takes place at 45. A test of the joints at 41 and 45 can be made by applying fluid pressure through the pipe sections 13 and 14, if such test is thought desirable.

By the construction thus provided, it will be readily appreciated that the tubes 38 and 39 which are connected to the movable chamber 31 have their rear ends free to expand or contract because of variations in temperature, and that such expansion can take place independently of any expansion or contraction which may take place in the tubes 37 and 36, which are connected to the movable chamber 32. It will be readily understood that the improved device can be used in transferring heat from a liquid to a liquid, a gas to a liquid, a liquid to a gas, or a gas to a gas.

The advantages of the improved construction are as follows: Suppose that the device is operating at a relatively high temperature, and a cool fluid is being admitted through the inlet 29. If at any time a large quantity of cold fluid were caused to enter very quickly, the tubes 36 and 37 would contract, but the tubes 38 and 39 which would remain comparatively hot would remain expanded. As the two chambers 31 and 32 are movable in the shell independently of each other, the tubes 36 and 37 can contract very easily without influencing the tubes 38 and 39 or producing any warping in the shell or developing any stresses therein. The converse is also true, that is, if the tubes 38 and 39 should in any event be subjected to a quick change in temperature, these tubes can expand or contract independently of the lower tubes without producing any warping of the shell or developing any stresses therein.

The purpose of the slip joint at 44 is to provide a slidable connection between the baffle plate section 43 and the middle baffle 16. It will be readily understood that as the three baffles 15, 16 and 17 are welded to the interior of the shell throughout the complete length, and in view of the fact that the baffle plate section 43 is not subjected to the quick changes in temperature which may be present in other parts of the shell, any expansion or contraction is taken up by this slip joint. From the arrangement of the baffle plates 15,

16 and 17, it will be readily appreciated that a warm fluid entering through the inlet 13 and being discharged through the outlet 14 will be caused to pass along the tubes in a direction opposite to the direction of flow of fluid through the tubes, if the fluid is admitted through the inlet 29. In this manner a true counterflow principle is present, enabling an efficient heat exchange.

From the above described construction it will be appreciated that a novel form of heat exchanger is provided, having many advantages and taking care of expansion and contraction of certain portions of the device relatively to other portions without causing any warping or strains to take place. Furthermore, a novel method is disclosed of constructing the device so that the various necessary tests against leakage can be made during the contraction, permitting the leaks which may be present to be repaired during the construction.

It will be understood that various changes in the detail of construction may be made without departing from the spirit or scope of the invention as defined by the appended claims.

I claim:

1. A device of the class described comprising a shell, heads for the shell, means providing three stationary chambers in the shell adjacent one end, means providing two movable chambers in the shell adjacent the other end, tubes connecting two of the stationary chambers to their respective movable chambers, tubes connecting both movable chambers to the third stationary chamber, means providing an inlet and an outlet for the space in the shell about the tubes, means providing an inlet leading to one of the stationary chambers, and means providing an outlet leading from another stationary chamber.

2. A device of the class described comprising a shell, heads for the shell, means providing three stationary chambers in the shell adjacent one end, means providing two movable chambers in the shell adjacent the other end, two sets of tubes, each connecting a stationary chamber with a movable chamber, baffles secured within the shell and extending from the stationary chambers and disposed adjacent said sets of tubes, a third set of tubes connecting the movable chambers to the third stationary chamber, a baffle arranged between the tubes of the third set and extending toward the stationary chambers, means providing an inlet and an outlet for the space in the shell about the tubes, means providing an inlet to one stationary chamber, and means providing an outlet from another stationary chamber.

3. A device of the class described comprising a shell, heads for the shell, means providing three stationary chambers in the

shell adjacent one end, means providing two movable chambers in the shell adjacent the other end, two sets of tubes, each connecting a stationary chamber with a movable chamber, baffles secured within the shell and extending from the stationary chambers and disposed adjacent said sets of tubes, a third set of tubes connecting the movable chambers to the third stationary chamber, a baffle arranged between the tubes of the third set and extending toward the stationary chambers, a baffle plate connecting the head of the shell adjacent the movable chambers to the last mentioned baffle, said baffle plate being connected to the last mentioned baffle by a slip joint, means providing an inlet and an outlet for the space in the shell about the tubes, means providing an inlet to one stationary chamber, and means providing an outlet from another stationary chamber.

4. A device of the class described comprising a shell, heads for the shell, means providing stationary chambers in the shell adjacent one end, means providing movable chambers in the shell adjacent the other end, a plurality of sets of tubes, there being two sets of tubes for each movable chamber, one set of tubes connecting the movable chamber to a stationary chamber and the other set of tubes connecting the same movable chamber with a stationary chamber adjacent to the last named stationary chamber, baffle plates extending from the stationary chambers toward the movable chambers, a baffle plate extending from the head adjacent the movable chambers toward the stationary chambers, said last named baffle plate being attached to the sides of the shell and provided with a slip joint intermediate its ends allowing independent longitudinal expansion and contraction.

5. A device of the class described comprising a shell, heads closing the ends of the shell, a stationary tube sheet mounted in the shell adjacent one end, two horizontal partitions dividing the space between the tube sheet and the adjacent head into upper, middle and lower stationary chambers respectively, three baffle plates mounted in the shell one above the other, the top and bottom baffle plates extending from the stationary tube sheet rearwardly and the middle baffle plate having its forward end spaced from the stationary tube sheet, means providing an upper and a lower movable chamber in the shell adjacent the other head, a set of tubes connecting said upper movable chamber to said upper and middle stationary chambers respectively, a set of tubes connecting the lower movable chamber to the middle and lower stationary chambers respectively, the tubes of each set being arranged upon both sides of the top and bottom baffles respectively, means providing an inlet and an outlet with a space in the shell about the tubes,

a port for the upper stationary chamber and a port for the lower stationary chamber.

6. A device of the class described comprising a shell, heads closing the ends of the
5 shell, a stationary tube sheet mounted in the shell adjacent one end, two partitions dividing the space between the tube sheet and the adjacent head into upper, middle and lower
stationary chambers respectively, three
10 baffle plates mounted in the shell one above the other, the top and bottom baffle plates extending from the stationary tube sheet rearwardly and the middle baffle plate having its forward end spaced from the station-
15 ary tube sheet, means providing two movable chambers in the shell adjacent the other head, a set of tubes connecting one of the

last named chambers to the upper and middle stationary chambers respectively, a set of
20 tubes connecting the other chamber to the middle and lower stationary chambers, tubes of each set being arranged upon both sides of the top and bottom baffles respectively, a
baffle plate connecting the other head of the
shell to the middle baffle, said baffle plate be-
25 ing connected by means of a movable joint, means providing an inlet and an outlet to the space in the shell about the tubes, a port for the upper stationary chamber and a port
for the lower stationary chamber. 30

In testimony whereof I have signed my name to this specification.

JULIUS E. KOBERNIK.