Dec. 17, 1957 A. HUET 2,816,740

PLATE HEAT EXCHANGER WITH REMOVABLE ENVELOPES

Filed April 2, 1954 3 Sheets-Sheet 1

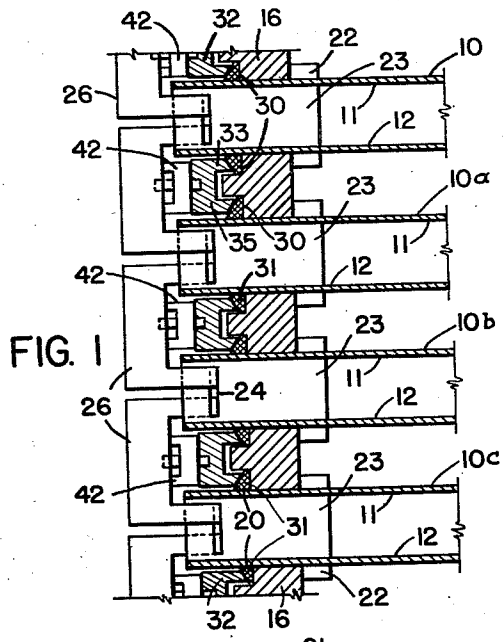



FIG. 1

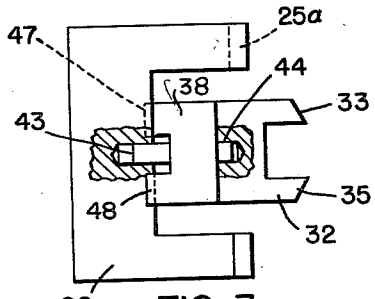



FIG. 3

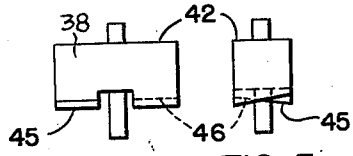



FIG. 4 FIG. 5

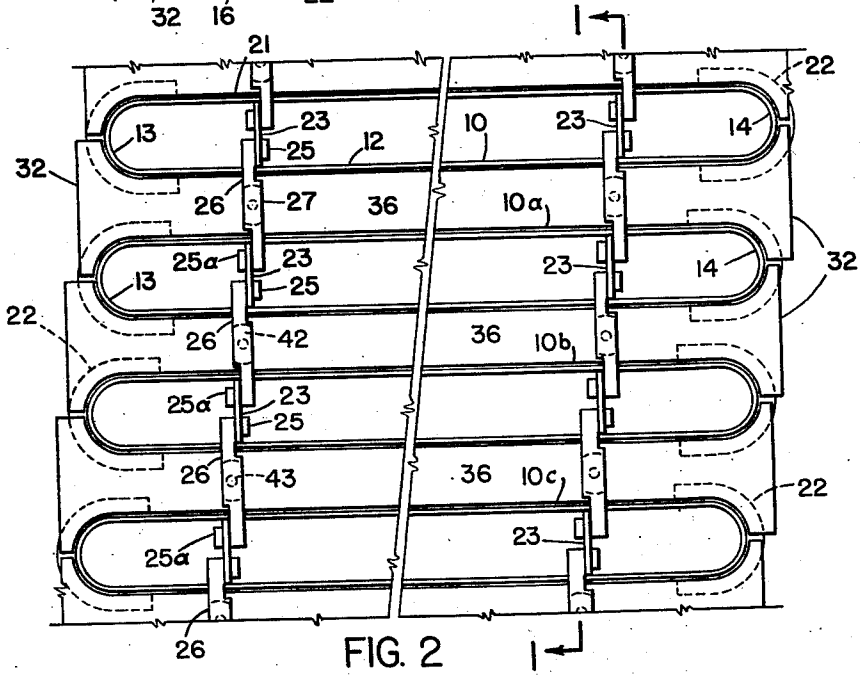



FIG. 2

INVENTOR
ANDRE HUET

BY James J. Wilson

ATTORNEY

PLATE HEAT EXCHANGER WITH REMOVABLE ENVELOPES

Filed April 2, 1954 3 Sheets-Sheet 2

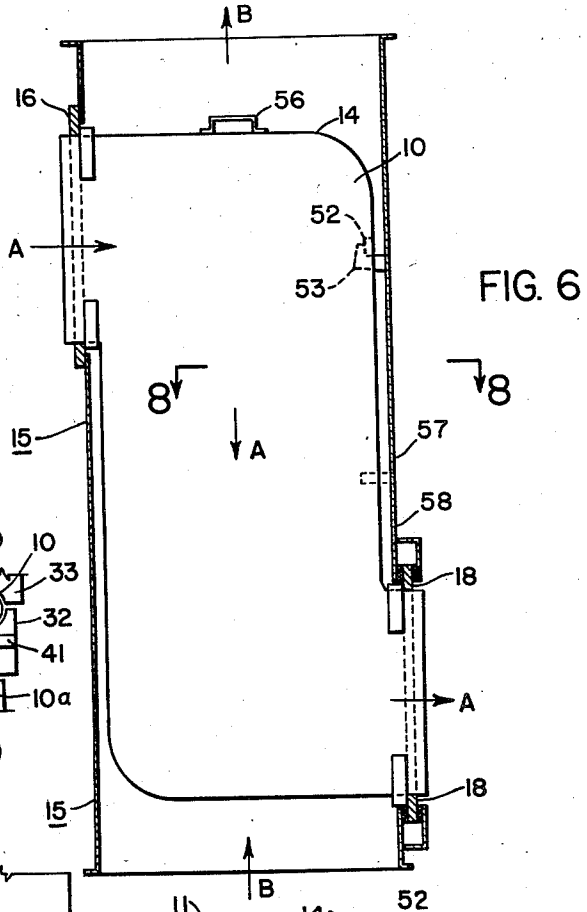



FIG. 6

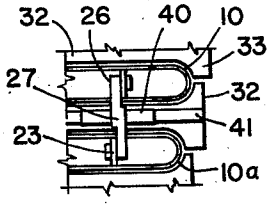



FIG. 10

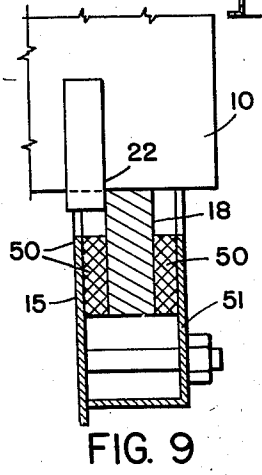



FIG. 9

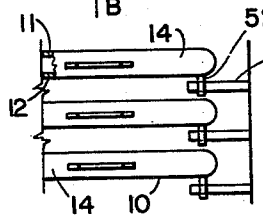



FIG. 7

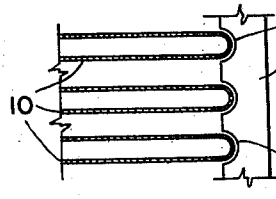



FIG. 8

INVENTOR
ANDRE HUET
BY
ATTORNEY

Dec. 17, 1957 A. HUET 2,816,740

PLATE HEAT EXCHANGER WITH REMOVABLE ENVELOPES

Filed April 2, 1954 3 Sheets-Sheet 3

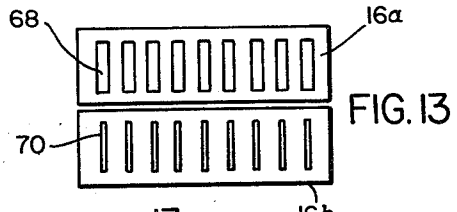



FIG. 13

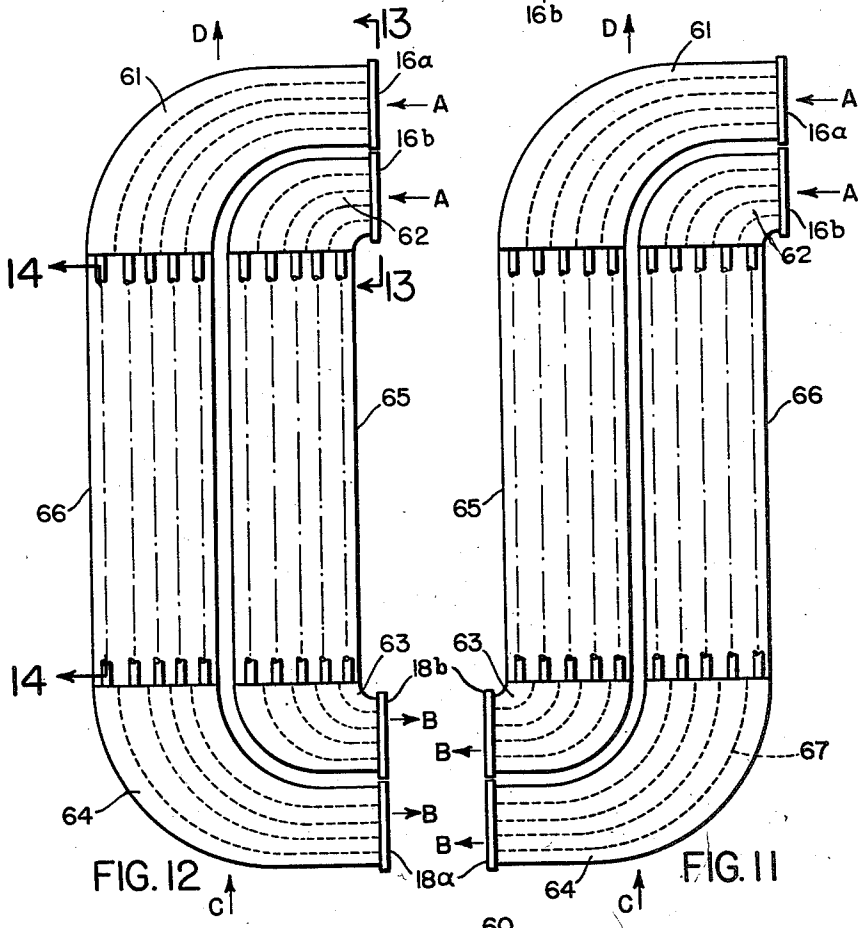



FIG. 12

FIG. 11

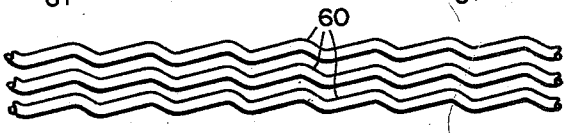



FIG. 14

INVENTOR
ANDRE HUET
BY
ATTORNEY

United States Patent Office 2,816,740 Patented Dec. 17, 1957



2,816,740

# PLATE HEAT EXCHANGER WITH REMOVABLE ENVELOPES

André Huet, Paris, France

Application April 2, 1954, Serial No. 420,681

7 Claims. (Cl. 257—245)

The present invention relates to heat exchange apparatus. It is known that in plate type heat exchangers one of the fluids which exchanges its heat with the other circulates inside envelopes each constituted by two parallel plates with the closures therebetween along one pair of sides so as to form a passage, while the other fluid circulates between the envelopes. Ordinarily, the inlet and outlet ends of these envelopes are welded on the apertures of plates, like tube plates, through which the fluid circulating in the envelopes is admitted or discharged. Such heat exchangers are difficult to clean, because the envelopes are rather close together and it is not easy to reach the space between them.

The present invention has for its object an exchanger with envelopes whose particularity resides in that the identical and interchangeable envelopes are mounted in removable manner on the tubular plates, so that it is easy to disassemble, change, and reassemble the envelopes and hence to clean them.

Moreover, the device for assembling and securing each envelope on the tubular plate is on the outside thereof, so that it can easily be manipulated from the outside. For the same reasons, the joint provided between the inlet of the envelope and the tubular plate is located on the outer face of the tubular plate. Any manipulation, repair, cleaning or change of envelope can be carried out from the outside of the exchanger.

The following description when read with reference to the accompanying drawings showing illustrative forms of the invention will best explain how the invention can be carried into effect:

Figure 1 is a section on line 1—1 of Figure 2 and illustrates the method of assembling envelope inlets of the exchanger of the invention with a tubular plate.

Figure 2 is a front view of Figure 1 seen from the exterior of the tubular plate.

Figures 3 to 5 relate to a construction using an eccentric intended to space the stirrup from the tubular plate.

Figure 6 represents diagrammatically in partial section the assembly of the exchanger.

Figure 7 is an enlarged detail view of a manner of attaching the envelopes on the housing of the exchanger.

Figure 8 is a section on a larger scale on line 8—8 of a portion of Figure 6.

Figure 9 represents, on a larger scale, the assembly, with sliding joint in the box, of the tubular outlet plate.

Figure 10, which shows an envelope inlet part viewed from the front, illustrates a variant of the spacing device for the stirrup by means of a wedge.

Figures 11 to 13 show a form in which tubes constitute part of the envelopes.

According to one embodiment of the invention, the envelopes whose inlets and outlets engage in the orifices of corresponding form of the tubular plate or plates have braces on their interior forming attachment points for the branches of stirrups disposed on the other side of the tubular plate. As the center of the stirrup, whose branches are secured in the braces of two neighboring



envelopes, is being spaced from the tubular plate, the envelopes are forced to engage in the openings of the tubular plate until a stop provided on each envelope limits this movement. The separation of the stirrup is effected, for example, by means of a wedge, eccentric, or similar device, which, instead of applying directly on the tubular plate, applies on a U-shaped part, each leg of which engages in the space between the tubular plate and one wall of an envelope, there to compress a joint of asbestos or the like, which insures tightness between the tubular plate and the periphery of each envelope.

Furthermore, there are provided in the box enclosing the envelopes of the exchanger locking devices and/or braces in which the sides of the enevlopes opposite the inlet or outlet are inserted, so as to insure the holding in position and the parallelism of said envelopes.

One of the tubular plates is preferably mounted with sliding joint on the box to permit expansion of the envelopes.

Finally, the box possesses moreover removable or articulated walls, to enable the removal and positioning of the envelopes.

As has been said, the essential particularity of the invention resides in the removable assembly of the inlets and outlets of the envelopes on the tubular plates of the exchanger. The latter consists of a group of envelopes **10**, **10***a*, **10***b*, **10***c*, etc. (Figure 1) internally traversed by air or other fluid in the direction of the arrows A (Figure 6), while another fluid exchanging its heat with the first circulates in the intervals between envelopes, in the direction of the arrows B (Figure 6). Each envelope **10** consists of spaced plates **11**, **12** (Figure 1) with the spaces therebetween closed along one pair of opposite edges as indicated at **14** (Figure 2). The group of envelopes **10** is contained in a housing **15** (Figure 6). On the tubular inlet plate **16** (Figures 1 and 6) as well as on the tubular outlet plate **18** (Figure 6) each inlet and outlet ends of the envelopes **10** are mounted in the following manner, which will be described for the inlet with reference to Figures 1 and 2.

The envelope inlet ends **20**, which are for example of oval section as is seen in Figure 2, penetrate into orifices **21** of corresponding form provided in the tubular plate **16**. On each envelope, in the vicinity of the inlet **20**, there are first provided stops **22** which, as is seen in Figure 1, limit the movement of the envelope **10** into the tubular plate **16**. Furthermore, at the inlet and on the interior of each envelope **10** there are provided at intervals braces **23** (Figure 2). These braces preferably extend over the entire length of the envelope which penetrates into the orifice **21** in tubular plate **16** to strengthen the envelope at that point and to prevent implosion.

In a slot **24** of the braces **23** are hooked the bent ends **25** of stirrups **26** (Figures 1 and 2). The hooking of a stirrup **26** occurs simultaneously in one of the envelopes **10** for one of its ends **25** and in the directly neighboring envelope **10***a* for the other end **25**. Also the hooking is such that it takes place on one side of the stirrup **26** for envelope **10** and on the other side for envelope **10***a*, as is seen in Figure 2. With this arrangement it is clear that if the middle portion **27** of each stirrup **26** is spaced outwardly from the outer face of the tube plate **16**, the penetration of the envelopes **10**, **10***a*, etc., into the openings **21** of the tube plate **16** is caused, until the stop **22** strikes against the inner face of the tube plate **16**.

Around the orifices **21** provided in the tube plate **16** to receive the inlets of the envelopes there is provided a recess or countersink **30** in which is disposed a gasket **31** of asbestos or the like. The branches of a U-shaped retainer **32** penetrate into this recess **30** of the tube plate **16** around the inlet end of the envelope **10**, etc. These branches **33**, **35** (Figure 1) engage in the recess **30** pro-

vided in the tube plate **16** around each envelope inlet and compress the gasket **31**. The U-shaped retainers **32** (Figure 2) are such that their central body portions **36** cover the space on plate **16** between two consecutive envelopes **10**, **10***a*, etc., and that their branches **33**, **35** in penetrating, as has been said above, into the interval between sides of recesses **30** in the tube plate **16** and the outer face of the inlet ends **20** of the envelopes **10**, etc., compress the gaskets **31** on exactly half of the periphery of each envelope. In this way said retainers **32** are interchangeable.

On the other hand, it is against the retainer **32** that a device **38** which spaces the stirrup **26** from the outer face of the tube plate **16** applies. This spacing device, which may be a simple wedge (Figure 10) or an eccentric which will be described below with reference to Figures 3 to 5, causes the stop **22** of each envelope end to be drawn against the tube plate **16** when the stirrup **26** is spaced from retainer **32**, as has been said above, and in addition each retainer **32** is applied against the gasket **31**, so as to insure tightness all around the envelope end.

It will be noted that the parts: envelopes **10**, stirrups **26** and retainers **32**, which serve for assembly and fixing the envelopes to the tube plates, are identical and interchangeable. As the braces **23** are in this case always located in the same position inside the envelopes **10**, it is necessary, during assembly, that said envelopes be slightly offset in relation to each other, as is seen in Figure 2, so as to take account of the thickness of the stirrup **26** which, as has been said above, is preferably hooked on one side in an envelope **10** and on the other side in the adjacent envelope **10***a*.

As has been said, the unit is entirely accessible from the outside of the tube plates **16** and **18**, as is also the gasket **31**, so that easiest assembly and disassembly is insured. Moreover, the stresses of tightening cancel out on the two sides of a tube plate between retainer **32** and stop **22**, whereby fatigue of said tubular plate is prevented.

The spacing to be provided between the stirrup **26** and the retainer **32** may be assured, for example, as shown in Figure 10, by means of a simple wedge **40** which slides in a groove **41** provided on the back of retainer **32** and which engages under the middle portion **27** of the stirrup **26**.

Instead of a wedge there may be provided an eccentric device such as shown in Figures 1 to 5. This eccentric device consists of a key **42** presenting pins **43**, **44** which pivot in the stirrup **26**, on the one hand, and in retainer **32** on the other hand, as is seen in Figure 3. The side of the key **42** which faces the stirrup **26** presents two slopes **45**, **46** (Figures 4 and 5) which engage in corresponding slopes **47**, **48** of the stirrup **26**. In this way, when the key **42** is rotated by any suitable means about the axis **43**, **44**, there is caused the ascent of the slopes and the separation of stirrup from retainer **32**. The keys **42** are shown in separated position in Figures 1 and 2.

The group of envelopes which are also assembled in the manner just described on the tube plate **18** is disposed in a housing **15**. The tube plate **18** is preferably mounted with sliding joint in the housing, as shown in Figures 6 and 9. In this way provision is made for the possible expansion of the envelopes in service. To this effect, the tube plate **18** is tightened between two joints **50** in an angle iron **51** fastened by any suitable means on the housing **15**.

To insure correct positioning and parallel arrangement of the envelopes inside the housing **15** there is provided on each envelope opposite its inlet end a lug **52** which comes to rest on a hook **53** rigid with the housing, as is seen in detail on Figure 7. On their mid-portion the envelopes preferably penetrate into a brace **54** provided on the housing and presenting notches **55** in which the edges of the envelopes engage, as is seen in greater detail in Figure 8.



To permit the removal of one or more envelopes, it suffices to operate the spacing devices **40** or **42** of the stirrups **26** corresponding to these envelopes, then to lift the latter out of the housing **15** by means of handle **56**. To facilitate the unhooking of the inlet and outlet of the envelopes from the apertures **21** of the tube plates **16**, **18**, the envelope may be given a slanting position, and to this effect the wall **57** of the housing **15** may be hinged at **58**, so that the envelope can be tipped.

The method of assembling the envelopes of the invention has been described in the case of an exchanger where the envelope is S-shaped. The same assembly may of course apply to exchangers in which as shown in Figures 12 and 13 the inlet and outlet of the inner fluids occurs on the same side of the housing, that is, when each envelope is U-shaped, the inlet and outlet tubular plates **16***a*, **18***a*, being in this case located one below the other.

The assembly applies not only to exchangers with envelopes but also to a case where a portion of these envelopes (generally the middle portion) is replaced by a panel of tubes connected on an inlet and an outlet in the form of envelopes as shown in Figures 11 and 12. This model may be of interest when operating with fluids at high temperature, as it permits the use of tubes **60** of soft steel for the middle portion of the passage or envelope which has the lowest temperature, while the ends of the fluid passages in the form of envelopes **61**, **62**, which are brought to higher temperatures, may be of special steels. Also there has been shown in Figure 10 the case of an exchanger with flat envelopes, but it is understood that the invention may apply also to the case where said envelopes or tubes are undulated, as shown in Figure 14, the inlets and outlets in the tubular plate then presenting corrugations coinciding with the corrugations of the envelope.

The different layers of the heat exchanger are constituted in their central portion by tubes **60**, corrugated as in Figure 14, and each row of tubes **60** is united on the one side to an entrance connector or distributor **61** or **62** and on the other side to an exit connector or distributor **63** or **64**. These connectors **62** and **64** are assembled respectively with the tube plates **16***b* and **18***a*, for example in a removable manner as described above.

According to the present invention, in the case where an envelope of the exchanger thus constituted would be too heavy and difficult of manipulation, it is subdivided as one sees in Figures 11 and 12, into two parts, an "external" part **65** and an "internal" part **66**, these being nested as shown.

The general shape of the envelope in Figure 12 is that of a U because the tubular entrance plates **16***a* and exit plates **18***a* are arranged on the same side of the apparatus.

The fluid which circulates on the inside of the envelopes enters in the direction of the arrows A and leaves in the direction of the arrows B. The fluid which circulates on the outside between the envelopes enters for example in the direction of the arrows C and leaves in the direction of the arrows D.

On the inside of the distributors **62**, **64**, are preferably provided partitions **67**, which have the effect of assuring the distribution of the internal fluid among the tubes **60** of the envelope.

One sees that with the arrangement adopted on Figure 12 the path of the internal fluid in the "internal" portion **65** of the layer is shorter than in the "external" portion **66** of the layer. In order that the temperature of the fluid which leaves the two portions in the direction of the arrows B is nevertheless the same, it is then provided, according to the invention, to modify the cross sections of the distributors **16***a* and **16***b*. For this purpose, as one sees on Figure 13, the tube plates **16***a*, **18***a* which correspond to the "external" portion **66** presents opening **68** with area clearly greater than that of the openings **70** of the lower plates **16***b*, **18***b*. There result variations in discharge in the flow of the internal fluid and a more rapid

circulation in the "external" portion 66 of the layer which offers the longer path to the fluid while the circulation in the "internal" portion 65 is slower. One thus succeeds in balancing the temperatures of the internal fluid at the exits.

It is of course understood that each of the tube plates 16*a*, 16*b*, 18*a*, 18*b*, instead of being in two parts could be in a single piece.

In the case where the tube plates are not located on the same side of the apparatus, but on two opposite sides, the general shape of the layer is that of an S as one sees on Figure 11. There again, the openings cut into the tube plates are such that the temperature of the fluid at the exit (arrow B) is the same for the external portion of the layer as for the internal portion.

What I claim is:

1. In a heat exchanger having hollow tubular envelopes constituting fluid passages and connected at their inlet and outlet ends into correspondingly shaped orifices in tube plates; stops adjacent each end of an envelope for limiting the engagement of the envelopes in the orifices of the tube plates; internal braces adjacent said ends of the envelopes; stirrups disposed externally of the tube plate, and having arms engageable with the braces of two adjacent envelopes; and means to space the middle portion of the stirrup from the outer face of the tube plate for tightly seating said envelopes.

2. A heat exchanger as recited in claim 1 wherein the spacing means includes a wedge with sloping sides mounted so as to be able to pivot between the stirrup and the tube plate.

3. A heat exchanger as recited in claim 1 wherein the spacing means includes an element that bears against a U-shaped part whose wings are formed to engage in the space between the outer wall of the envelope and the tube plate and there to compress a joint insuring tightness over the entire periphery of the aperture of the envelope.



4. A heat exchanger as recited in claim 1 wherein the major portions of the envelope passages for one fluid consist of corrugated tubes whose ends are united to entrance and exit distributors mounted in a removable manner on entrance or exit tube plates.

5. A heat exchanger as in claim 4 wherein the envelope is sub-divided into two or more nested portions for the purpose of facilitating its handling.

6. A heat exchanger as in claim 5 wherein the cross sections of the entrance or exit distributors of each portion of envelope are so related to the circulation of the fluids in the exchanger that the temperature of the internal fluid at the exit of the different nested portions is the same.

7. A new industrial product, comprising a heat exchanger having tube plates, an envelope constituted of a row of corrugated tubes whose ends are united to distributors, the entrance and the exit of the distributors being mounted in a removable manner on the tube plates of the exchanger.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| Re. 17,973 | Mosher | Feb. 17, 1931 |
| 1,734,962 | Clarke | Nov. 12, 1929 |
| 1,916,888 | Malott | July 4, 1933 |
| 2,147,475 | Wilbur | Feb. 14, 1939 |