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HEAT EXCHANGER

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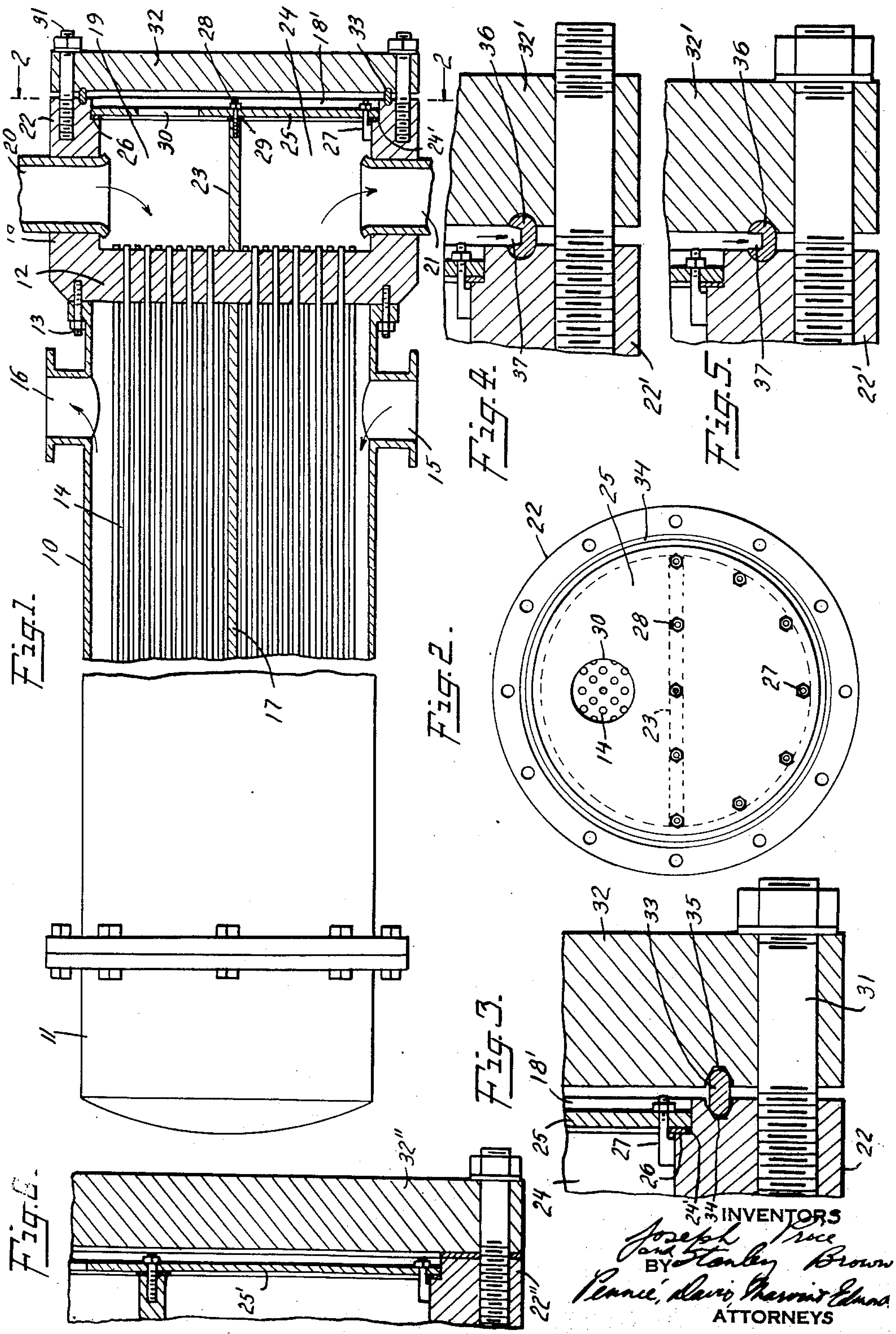

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HEAT EXCHANGER

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This invention relates to heat exchangers of the shell and tube type comprising an outer shell of cylindrical or other form and a bundle of tubes within this shell, the tubes being mounted in a tube sheet associated with or forming part of a stationary head secured to the shell. The invention is particularly concerned with the construction of the stationary head and the sealing of the joint between it and the cover plate of the head.

In multi-pass heat exchangers it is the usual practice to provide one or more partitions within the stationary head, the partition or partitions being arranged in such a manner that they divide the entire space between the tube sheet and the stationary head cover plate into a series of chambers, each communicating with a separate group of the heat exchanger tubes. The partition or partitions ordinarily extend from the tube sheet to the stationary head cover plate, and the joint between the cover plate and the corresponding end of each partition is sealed. The cover plate is secured to the stationary head by bolts or the like and when fluid under considerable pressure is supplied to the cover plate, the fluid pressure has a tendency to force the stationary head cover plate away from its seat and/or to cause the cover plate to bow outwardly and strain the joint between it and the stationary head and cause leakage between the cover plate and the corresponding end or ends of the partition or partitions which divide the interior of the stationary head into the aforementioned series of chambers. One way of maintaining the joint between the stationary head and the cover plate tight under high fluid pressures, is to employ exceptionally large bolts and increase the diameter of the cover plate and the corresponding stationary head flange in order to accommodate such large bolts, and one way of preventing the cover plate from bowing outwardly under high fluid pressures is to brace or stay it in some way. Both of these expedients are expensive and greatly increase the size of the heat exchanger.

In accordance with the present invention, a novel joint is provided between the flange of the stationary head and the outside cover plate, which remains tight under the highest working fluid pressures to which the heat exchanger is subjected and which does not require exceptionally large bolts or any increase in diameter of the cover plate and the corresponding flange of the stationary head.

This novel joint includes a metal sealing ring which is forced into registering grooves in the corresponding surfaces of the cover plate and the stationary head flange, these grooves being of less dimension than the corresponding portions of the ring so that the ring is wedged into the grooves when the cover plate bolts are tightened down. The sealing ring may be provided with an internal radial slot, making it U-shaped in cross-section, this slot communicating with the high pressure side of the heat exchanger in such a way that the ring is forced more tightly into its seat in response to increased fluid pressures in the exchanger to more tightly seal the joint between the stationary head and its cover plate.

Also, in accordance with the present invention, an inner cover plate of light construction is secured to the stationary head within the outer cover plate and forms a chamber between the two cover plates which communicates with the inlet of the exchanger so as to be subject to the highest fluid pressure to which the exchanger is subjected. The partition or partitions in the stationary head are connected to the inner cover plate and since the fluid pressures on both sides of the inner cover plate are equalized, the inner cover plate cannot bow outwardly under high pressures and the joints between it and the partition or partitions remain tight at all times. In fact, since the outer surface of the inner cover plate is subjected uniformly to the highest fluid pressures to which the heat exchanger is subjected and as the inner surface of the inner cover plate is not subjected uniformly to the highest fluid pressure, the pressure on the outer surface of the inner cover plate is slightly higher and tends to hold the plate on its seat and more tightly seal the joint between it and the partition or partitions. With this construction the outer

cover plate can be made lighter and smaller in size.

Other advantages of the invention will be more apparent upon considering the following detailed description which is to be taken in conjunction with the accompanying drawing, in which:

Fig. 1 is an elevation partly in section of a heat exchanger embodying the invention;

Fig. 2 is a transverse section thereof as seen along the line 2—2 of Fig. 1;

Fig. 3 is an enlarged fragmentary section of the joint between the stationary head and the outer cover plate;

Fig. 4 illustrates a modified form of sealing ring before the outer cover plate is tightened down;

Fig. 5 is a similar view illustrating the condition of the sealing ring after the outer cover plate has been tightened down; and

Fig. 6 is a view of another modified form of the invention.

In the drawing, numeral 10 designates the cylindrical shell of the heat exchanger, having a cap 11 closing one end thereof, and connected to a tube sheet 12 by means of a plurality of bolts 13. The shell 10 contains a number of tubes 14 which are expanded into or otherwise secured to the tube sheet 12. The shell 10 is provided with a fluid inlet 15 and a fluid outlet 16, and a longitudinally extending baffle 17 which divides the shell into two compartments communicating with each other near that end of the shell adjacent the cap 11. This arrangement is such that the fluid entering the shell through the inlet 15 traverses the length of the shell to the cap 11 and then flows back toward the tube sheet 12 and is discharged through outlet 16. The tubes 14 may be of U-shaped construction with both ends of each tube secured through the tube sheet 12, or they may be substantially straight tubes having their ends secured to tube sheets located at the opposite ends of the shell 10. In either case the tubes are arranged so as to provide for a multipass flow of the fluid supplied to the tubes.

The tube sheet 12 is illustrated as forming an integral part of the stationary head 18. This stationary head consists of a single block of metal of relatively massive proportions adapted to withstand high pressures. The stationary head 18 is provided with a chamber 19 and with a fluid inlet 20 which communicates with chamber 19. The stationary head 18 is also provided with an outlet 21 and has an opening at its outer end which defines the flange 22 and which is of sufficient size to permit ready access to the chamber 19 and to the tube sheet 12, whereby the tubes 14 may be cleaned at intervals or replaced as may be necessary or desirable. A partition 23 extends outwardly from the tube sheet 12 and forms a second chamber 24 within the stationary head 18 which communicates with the outlet 21.

The stationary head 18 is counter-bored to provide the seat 26 for the inner cover plate 25, which is made relatively light and thin. This inner cover plate 25 is secured on the seat over gasket 24′ by means of a plurality of threaded studs 27, which are secured to the stationary head 18 and permit ready removal of the plate for cleaning and repairing the interior of the exchanger. The outer end of the partition 23 is secured to the inner cover plate 25 by means of bolts 28, and a gasket 29 is interposed between the partition 23 and the inner cover plate 25 to seal the joint between them. An opening 30 in the inner cover plate 25 connects the inlet or high pressure chamber 19 with the outer surface of the inner cover plate for a purpose to be explained later.

Secured to the flange 22 of the stationary head 18 by means of a plurality of relatively large bolts 31 is the outer cover plate 32 which is made relatively large and heavy as compared to the light and thin inner cover plate 25. This outer cover plate 32 forms with inner cover plate 25 the chamber 18′ within the stationary head 18.

Interposed between the cooperating surfaces of the stationary head flange 22 and the inner surface of outer cover plate 32 is a sealing ring 33 of steel or other suitable material. As illustrated especially in Fig. 3, the sealing ring 33 is substantially rectangular in cross-section and the rounded axial edges thereof are seated in the grooves 34 and 35 formed in the cooperating surfaces of stationary head flange 22 and outer cover plate 32, respectively. These grooves are formed with tapering walls and are of less dimension than the ring 33, i. e., the ring is slightly larger than the grooves and engages the outer sloping sides of the grooves before it engages the inner sides thereof, so that the ring is not only wedged axially into the grooves when the cover plate 32 is tightened down, but is also compressed radially into the grooves. Because of this construction, the more the bolts 31 are tightened, the tighter will be the seal formed by the sealing ring 33. The radial compression of ring 33 causes it to act like a spring when released, so that as the joint tends to loosen slightly in response to high pressures acting upon the inner surface of the outer cover plate 32, the ring 33 will expand radially to maintain the joint tight. Also, the differential pressure between the inner and outer axial surfaces of the ring will tend to cause the ring to seat more securely in the grooves 34, 35, as the pressure within the exchanger increases.

The inner cover plate 25 is so arranged that fluid of the highest pressure to which the exchanger is subjected is applied to the

outer surface of inner cover plate 25 and forces the latter inwardly against its gasket to more securely seal the joint between it and its seat 26 and also to force the inner cover plate 25 against the partition 23 to more tightly seal the joint between them. This arrangement compensates for any tendency of the inner cover plate 25 to bow outwardly in response to excessive pressures to which it may be subjected and the pressure differential between the chamber 18′ and the outlet chamber 24, due to the pressure loss through the tubes 14, serves to procure the effect just described. Furthermore, because the outer cover plate is not required to form a seal against the partition 23, this cover plate may be made lighter and smaller than would be feasible if the inner cover plate were not provided.

A modified form of the sealing ring is illustrated in Figs. 4 and 5, Fig. 4 illustrating the ring before it is compressed and Fig. 5 illustrating the ring after it is compressed by the tightening down of the outer cover plate 32′ upon the flange 22′ of the stationary head. The sealing ring 36 is U-shaped in cross-section with the slot 37 thereof on its inner surface. In its initial form, the sealing ring 36 is expanded with its side walls diverging as illustrated in Fig. 4, so as to compensate for the partial collapse thereof which naturally takes place because of its unsupported lateral walls when high pressure is applied thereto upon tightening down of the outer cover plate 32′. The corresponding grooves in the cooperating surfaces of the stationary head flange 22′ and the outer cover plate 32′ are shaped to correspond to the compressed configuration of the ring 36 and are accordingly of different curvature than that of the corresponding sides of the ring when it is expanded, as is indicated in Fig. 4.

After the ring 36 is compressed, it has the form illustrated in Fig. 5, the lateral curved edges of the ring having been forced into the grooves in the stationary head flange 22′ and the outer cover plate 32′ to fit closely therein, this action taking place as the result of the compression of the ring in the manner described. The shape of the ring 36 is such that the fluid pressure applied to the inner surface thereof is distributed outwardly in all directions from the surfaces of the slot 37, so that the ring is seated more tightly in the grooves and the effectiveness of the seal increases with the pressure to which the ring 36 is subjected.

A modified form of the invention is illustrated in Fig. 6, which differs from the forms illustrated in the preceding drawing in that the sealing ring between the flange of the stationary head and the outer cover plate is omitted, the joint between them being sealed by a gasket interposed between them. The joint between the stationary head flange 22″ and the outer cover plate 32″ is secured by a plurality of bolts distributed around the periphery thereof. In this arrangement the inner cover plate 25′ is provided to equalize the fluid pressures at the inner surface of the outer cover plate 32″ for the purpose described. Inasmuch as other details of the modified form of the exchanger illustrated in Fig. 6 are the same as those described in connection with the preceding figures of the drawing, it will not be necessary to repeat this description.

It is to be understood that the invention is not limited to the particular embodiments thereof which are illustrated in the accompanying drawing, but includes such modifications as fall within the scope of the appended claims. For example, the various modified forms of the invention or parts thereof, may be used with heat exchangers or other fluid pressure apparatus, and various combinations of the several forms of the invention may be used as desired or required. Also, while the tube sheet 12 has been illustrated and described as integral with the stationary head 18 as the preferred form of construction, the tube sheet 12 may be made separate and secured to the head 18 in any suitable way.

We claim:—

1. A heat exchanger comprising a head having a chamber therein and an opening for access to said chamber, a plurality of tubes communicating with the chamber, a cover plate for the opening in the head, a sealing ring between the cover plate and the cooperating surface of the head, said ring being substantially U-shaped in cross-section, the cooperating surfaces of the cover plate and head having registering grooves for receiving the corresponding edges of the ring, and means for tightening the cover plate on the head.

2. A heat exchanger comprising a head having a chamber therein and an opening for access to said chamber, a plurality of tubes communicating with the chamber, a cover plate for the opening in the head, a sealing ring between the cover plate and the cooperating surface of the head, said ring being substantially U-shaped in cross-section, the cooperating surfaces of the cover plate and head having registering grooves for receiving the corresponding sides of the ring with the recess in the ring communicating with the space between said surfaces, and means for tightening the cover plate on the head to partially compress the ring into the corresponding grooves.

3. A heat exchanger comprising a head having a chamber therein and a opening for access to said chamber, a plurality of tubes communicating with the chamber, a partition in the chamber dividing it into a plurality of compartments each communicating with

different tubes, a relatively heavy cover plate for the opening in the head, a relatively light inner cover plate forming a second chamber in the head, and connections between at least one of the said compartments and the said second chamber.

4. A heat exchanger comprising a head having a chamber therein and an opening for access to said chamber, a plurality of tubes communicating with the chamber, a partition in the chamber dividing it into a plurality of compartments, one of which is an inlet compartment, a cover plate for the opening in the head, an inner cover plate forming a second chamber in the head, and connections between the inlet compartment in the chamber and the said second chamber.

5. A heat exchanger comprising a head having a chamber therein and an opening for access to said chamber, a partition in the chamber dividing it into a plurality of compartments each communicating with different tubes, a cover plate for the opening in the head, an inner cover plate forming a second chamber in the head, means securing the inner cover plate to the partition, and connections between at least one of the compartments and the said second chamber.

6. A heat exchanger comprising a head having a chamber therein and an opening for access to the chamber, a tube sheet on the head, a plurality of tubes connected to the tube sheet and communicating with the chamber, an outer cover plate for the opening in the head, an inner cover plate forming an enclosed space with the outer cover plate, a partition connected at one end to the tube sheet and at the other end to the inner cover plate for dividing the chamber into a pair of chambers each communicating with different tubes, a fluid inlet connected to one compartment, and connections between the inlet compartment and the said enclosed space for creating a fluid pressure on the outer surface of the inner cover plate.

7. A heat exchanger comprising a head having a chamber and an opening for access to said chamber, a plurality of tubes communicating with the chamber, an outer cover plate for the opening in the head, an inner cover plate forming an enclosed space with the outer cover plate, a sealing ring between the outer cover plate and the head, fluid connections between one side of the sealing ring and the enclosed space, and fluid connections between the chamber and the enclosed space.

8. A heat exchanger comprising a head having a chamber and an opening for access to said chamber, a plurality of tubes communicating with the chamber, an outer cover plate for the opening in the head, an inner cover plate forming an enclosed space with the outer cover plate, a partition in the chamber engaging the inner cover plate and dividing the chamber into a plurality of compartments each communicating with different tubes, a sealing ring between the outer cover plate and the head, fluid connections between one side of the sealing ring and the enclosed space, and fluid connections between the chamber and the enclosed space.

In testimony whereof we affix our signatures.

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