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HEAT EXCHANGER WITH SPRING BIASED SUPPORT

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2 Sheets-Sheet 1

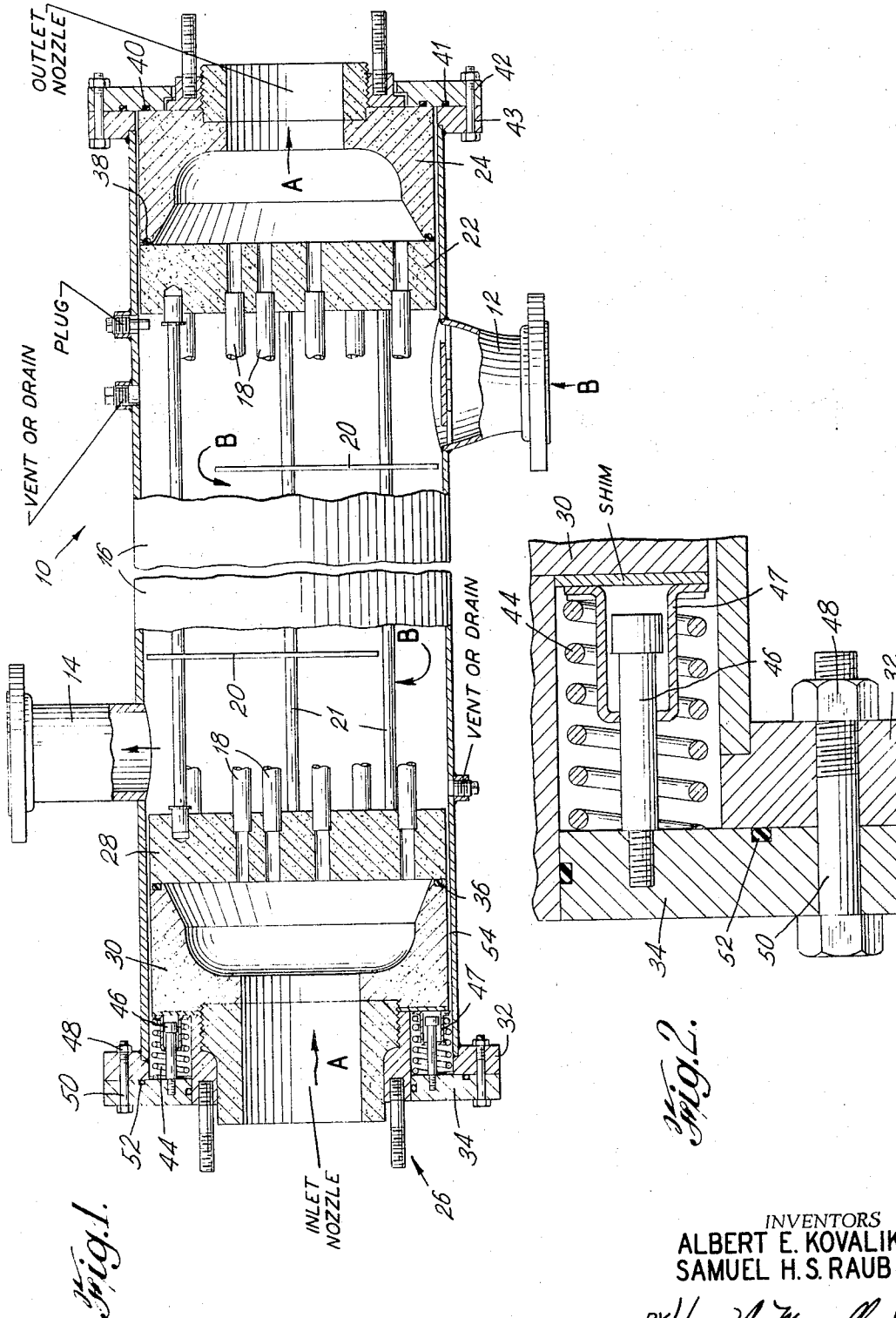


Fig. 2.

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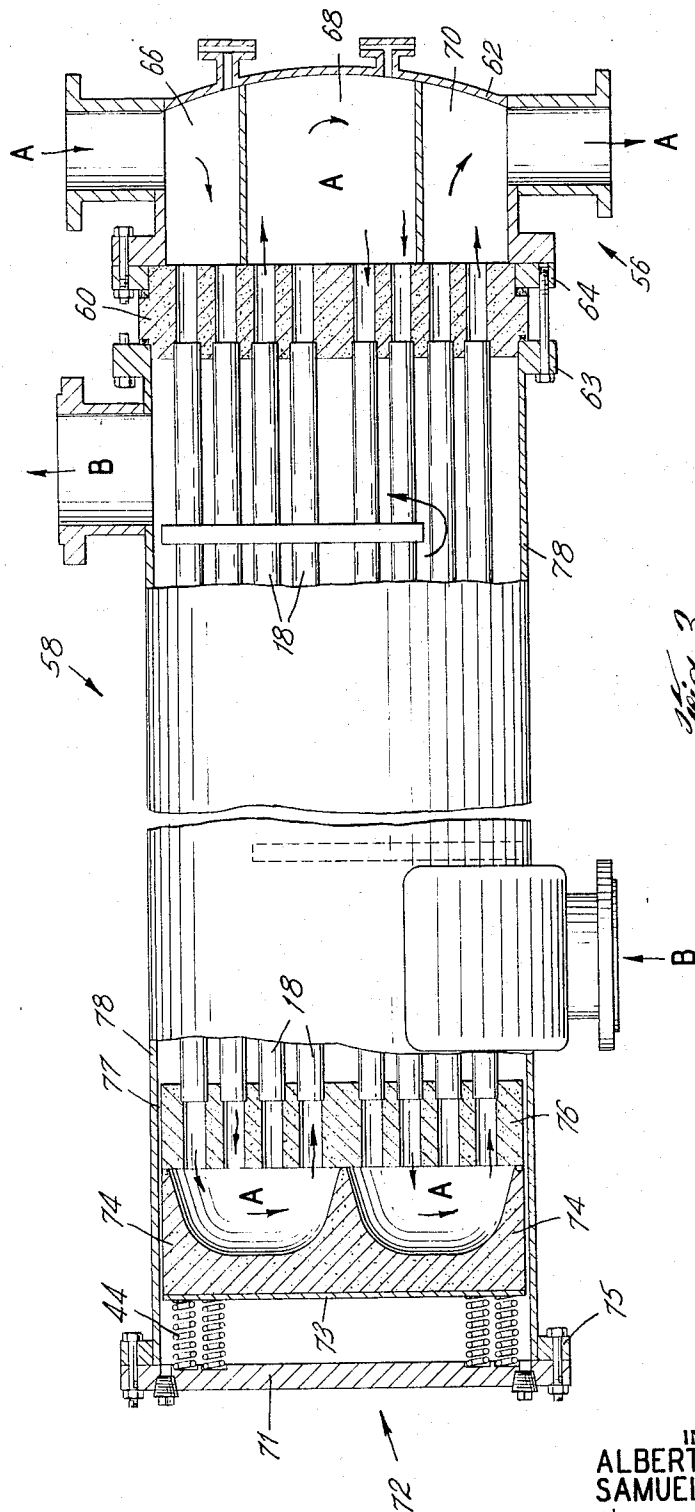


Fig. 3

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1

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HEAT EXCHANGER WITH SPRING BIASED SUPPORT

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9 Claims. (Cl. 165—81)

The present invention relates, in general to improvements in heat exchangers and, in particular, to heat exchangers of the shell and tube type, and more particularly to totally enclosed tube bundle heat exchangers of the character containing non-metallic tubes of carbon or graphite construction for conducting corrosive fluid media.

The particular improvement advanced by this invention is directed to a novel floating head arrangement.

The principal object of the invention is to provide a floating head arrangement including a tube sheet and closure therefor, wherein the gaskets between the end cover domes and the tube sheets on both ends of the enclosed tube bundle, and the gaskets between the fixed end plate and the inner dome are sealed by spring pressure on the floating end. The use of springs in this application is unique in that they maintain the above-noted gaskets leak tight under all operating conditions of temperature and pressure. The tube bundle comprising a plurality of tubes is conventionally stayed by baffles spaced on normal centers along the tube length.

Since the invention is primarily concerned with a floating head structure arrangement to be used with the more or less conventional forms of totally enclosed tube bundle heat exchangers, the other portions of such exchanger including the shell and the fixed end of the tube bundle although shown in the accompanying drawings will not be described in great detail since such heat exchangers are well known and understood by those skilled in the art.

The main object and other objects and advantages of the invention will be readily understood from the following detailed description when read in conjunction with the accompanying drawing, which illustrates the preferred forms of the device, and in which like characters of reference designate like parts throughout the several views, and in which:

FIGURE 1 is a side elevational view, partly in section showing the preferred form of the invention;

FIGURE 2 is a greatly enlarged fragmentary view, largely in section showing the details of the spring loading means applied to the dome of the heat exchanger illustrated in FIGURE 1; and

FIGURE 3 is another side elevational view, partly in section showing another form of the invention.

Referring to the drawings, and particularly to FIGURES 1 and 2, there is shown a single pass heat exchanger of the shell and tube type generally indicated by the numeral 10. An inlet end casting 12 and an outlet end casting 14 are conventionally welded to the longitudinal metallic shell 16. Inside the shell 16 is mounted a bundle of uniformly disposed impervious carbon or graphite tubes 18, which pass through correspondingly spaced holes (not shown) in baffles 20. The baffles 20 are secured to and generally spaced along the tie rods 21 which pass through the baffles 20. A fixed tube sheet 22 of carbon or graphite enclosed within the shell 16 and supporting the tubes 18 is disposed adjacent to and connects with a single pass fixed outlet dome or cover 24 of carbon or graphite. At the floating end 26 of the heat exchanger 10 is a floating tube sheet 28 of carbon or graphite which likewise supports the tubes 18 and is connected to a single pass floating inlet dome or cover

2

30 also of carbon or graphite. The tubes 18 as is done in the art are conventionally cemented into "open-ended" sockets in the tube sheets 22 and 28.

An end plate 34 is clamped and gasketed to flange 32, which is suitably secured preferably by welding to the shell 16 adjacent the floating end 26 of the heat exchanger 10.

The improved feature of the heat exchanger 10 centers around the floating end members which permit the tube bundle (tube sheets, tube baffles and tie rods) to be under continuous compressive loading and seals the gaskets 36 and 38 between the covers 30 and 24 and tube sheets 22 and 28, and the gasket 40 between the fixed cover 24 and end plate 42. Gasket 41 provides the seal between the end plate 42 and the flange 43. In contrast to the above-described construction, it should be noted that in conventional heat exchanger designs the tubes are in tension.

A plurality of compression springs 44 aligned about studs 46 are positioned about the periphery of the floating cover 30. A cup-shaped member 47 maintains the springs 44 in place about the studs 46 should the end plate 34 be removed by loosening the nuts 48 from the bolts 50 which clamp together the end plate 34, gasket 52 and flange 32. The springs 44 bear against the floating outlet cover 30 which is seated against the floating tube sheet 28. The floating tube sheet 28 in turn bears toward the fixed tube sheet 22, thus loading the tubes 18 in compression. The tubes 18 when loaded in compression "hunt" their way through the baffles 20 and brace against them and thus tube cutting caused by vibration of taut and lightly supported tubes is minimized and may even be eliminated entirely. Since carbon and graphite is much stronger in compression than in tension, it is highly advantageous to utilize the invention for such shell and tube type heat exchangers employing a tube bundle assembly. Moreover, continuous spring loading follows the gasket material under all conditions of cold flow, maintains pressure over full range of differential thermal expansion, and eliminates complete relaxation of bolt loading which occurs when the bolt heads rust against their bearing surfaces or when the nuts vibrate loose. Further, the spring loading under these conditions control the gasket loading as opposed to the excessive and variable bolt loading necessary when standard bolts are used to seal the gaskets. In addition, passage means such as clearance 54 between the shell wall 16 and the floating dome 30 and tube sheet 28 permits hydraulic pressure to be impressed against the dome 30 in the direction of the spring loading thereby increasing the effectiveness of the gasket sealing. For reasons of safety, the operating pressures in the shell are generally equal to or greater than the pressure in the tubes which are of carbon or graphite. It should be realized that in such an "armored" construction all of the carbonaceous members of the heat exchanger are totally enclosed within the shell.

It should also be noted at this time that the longitudinal force on the tubes can always be maintained in compression by proper proportioning of the area of the inner side of the tube sheet to the area of the outer end surface of the dome which is under hydraulic shell pressure.

In FIGURE 3, there is shown a variation of the structure for effecting the improvement hereinbefore described for such shell and tube type heat exchangers. This structure accomplishes the objects of the invention in a four pass shell and tube heat exchanger. In this embodiment, the fixed end 56 of the heat exchanger 58 is open at the fixed tube sheet 60 so that any suitable dome or cover 62 can be readily secured by bolts to ring 64 which is in turn secured in a like manner to flange 63. Cover 62 is provided with three chambers 66, 68, and 70 which permit the

fluid "A" to be routed through the tubes 18 four times (see reference arrows). At the floating end 72 of the heat exchanger 58 a plurality of compression springs 44 bear against a two compartment floating dome or cover 74 via plate 73 which in turn bears against the floating tube sheet 76. End plate 71, which provides a suitable end bearing wall for the springs 44, is secured to flange 75 which is generally welded to the shell wall 78.

In this modification, clearance 77 between the shell wall 78 and the floating dome 74 and the tube sheet 76 also permits hydraulic pressure to be impressed against the dome 74 in the direction of the spring loading thereby increasing the effectiveness of the gasket sealing. As shown in FIGS. 1 and 3, the path of the second fluid "B" is also illustrated by reference arrows.

In essence then, the improved heat exchanger of the invention provides compressive spring loading of the tube bundle which control the gasket loading as opposed to the excessive and variable bolt loading necessary when standard bolts are used to seal the gaskets in heretofore totally enclosed tube bundle heat exchangers. The advantages of the heat exchangers in summary are that such apparatus provides spring loading of the gaskets under all conditions of cold flow, maintains pressure over full range of differential thermal expansion and eliminates relaxation of bolt loading which occurs when the bolt heads rust against their bearing surfaces or when the nuts vibrate loose.

What is claimed is:

1. A heat exchanger, comprising a shell, a tube bundle therein, a floating tube sheet for slidably supporting one end of said tube bundle within said shell, a flange on said shell at the floating tube sheet end thereof, a floating cover abutting said floating tube sheet, an end plate for the floating end of said heat exchanger, means for securing said end plate to said flange, resilient loading means disposed between said end plate and said floating cover and passage means for enabling the shell side fluid to impress against said floating cover in the direction of said resilient loading means whereby the tubes of said tube bundle are compressively loaded.

2. The heat exchanger of claim 1 wherein said resilient means disposed between said end plate and said floating cover comprise a plurality of compression springs.

3. The heat exchanger of claim 2 wherein said compression springs are positioned about a plurality of studs which maintain said compression springs in place against said end plate.

4. A heat exchanger, comprising a shell, a tube bundle therein, a fixed tube sheet for supporting one end of said tube bundle within said shell, a fixed cover and a gasket between said fixed tube sheet and said fixed cover, a floating tube sheet for slidably supporting the opposite end of said tube bundle within said shell, a flange on said shell at the floating tube sheet end thereof, a floating cover and a second gasket between said floating tube sheet and said floating cover, an end plate for the floating end of said heat exchanger, means for securing said end plate to said flange, resilient loading means disposed between said end plate and said floating cover and passage means for enabling the shell side fluid to impress against said floating cover in the direction of said resilient loading means whereby said gaskets are compressively loaded.

5. A heat exchanger, comprising a shell, a tube bundle therein, a fixed tube sheet for supporting one end of said tube bundle within said shell, a fixed cover and a gasket between said fixed tube sheet and said fixed cover, an end plate for the fixed end of said heat exchanger and a second gasket between said fixed cover and said end plate, a

floating tube sheet for slidably supporting the opposite end of said tube bundle within said shell, a flange on said shell at the floating tube sheet end thereof, a floating cover and a third gasket between said floating tube sheet and said floating cover, a second end plate for the floating end of said heat exchanger, means for securing said end plate to said flange, resilient loading means disposed between said second end plate and said floating cover and passage means for enabling the shell side fluid to impress against said floating cover in the direction of said resilient loading means whereby all of said gaskets are compressively loaded.

6. A heat exchanger, comprising a shell, a tube bundle therein, an impervious carbonaceous tube sheet fixed to one end of said shell for supporting one end of said tube bundle within said shell, an impervious carbonaceous fixed cover and a gasket between said fixed tube sheet and said fixed cover, an impervious carbonaceous floating tube sheet for slidably supporting the opposite end of said tube bundle within said shell, a flange on said shell at the floating tube sheet end thereof, an impervious carbonaceous floating cover and a second gasket between said floating tube sheet and said floating cover, an end plate for the floating end of said heat exchanger, means for securing said end plate to said flange, resilient loading means disposed between said end plate and said floating cover and passage means for enabling the shell side fluid to impress against said floating cover in the direction of said resilient loading means whereby said gaskets and the tubes of said tube bundle are compressively loaded.

7. A heat exchanger comprising a shell, an impervious carbonaceous tube sheet fixed to one end of said shell, an impervious carbonaceous floating tube sheet at the opposite end of said shell, a bundle of substantially parallel impervious carbonaceous tubes extending between said tube sheets and communicating with corresponding open-ended sockets in said tube sheets, a flange on said shell at the floating tube sheet end thereof, an impervious carbonaceous floating cover abutting said floating tube sheet, an end plate for the floating end of said heat exchanger, means for securing said end plate to said flange, resilient loading means disposed between said end plate and said floating cover and passage means for enabling the shell side fluid to impress against said floating cover in the direction of said resilient loading means whereby said tubes are compressively loaded between said tube sheets.

8. The heat exchanger of claim 7 wherein said resilient means disposed between said end plate and said floating cover comprise a plurality of compression springs.

9. The heat exchanger of claim 8 wherein said compression springs are positioned about a plurality of studs which maintain said compression springs in place against said end plate.

References Cited by the Examiner

UNITED STATES PATENTS

464,159	12/1891	Link	165—82
826,966	7/1906	Schneible	165—82
1,591,174	7/1926	Mailey	165—81 X
2,887,303	5/1959	Reys	165—82
2,965,787	10/1960	Raub	165—82

FOREIGN PATENTS

1,211,918	10/1959	France.
908,028	4/1954	Germany.

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