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J. W. BEVEVINO

3,398,787

EXPANSION AND CONTRACTION MEANS FOR A HEAT EXCHANGER

Filed Oct. 11, 1966

2 Sheets-Sheet 1

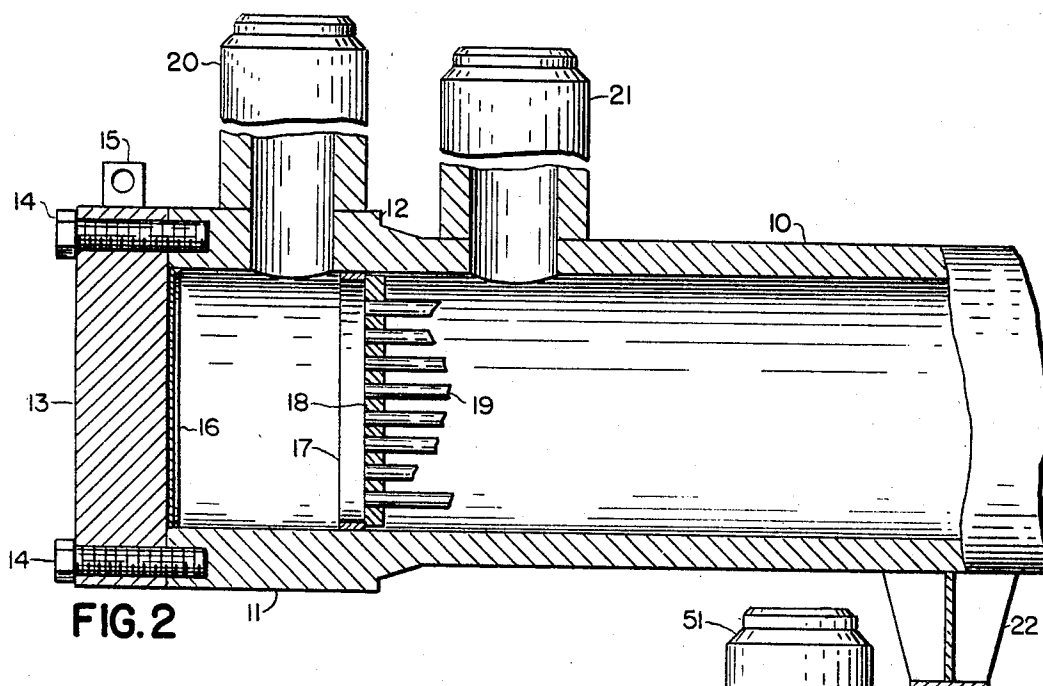


FIG. 2

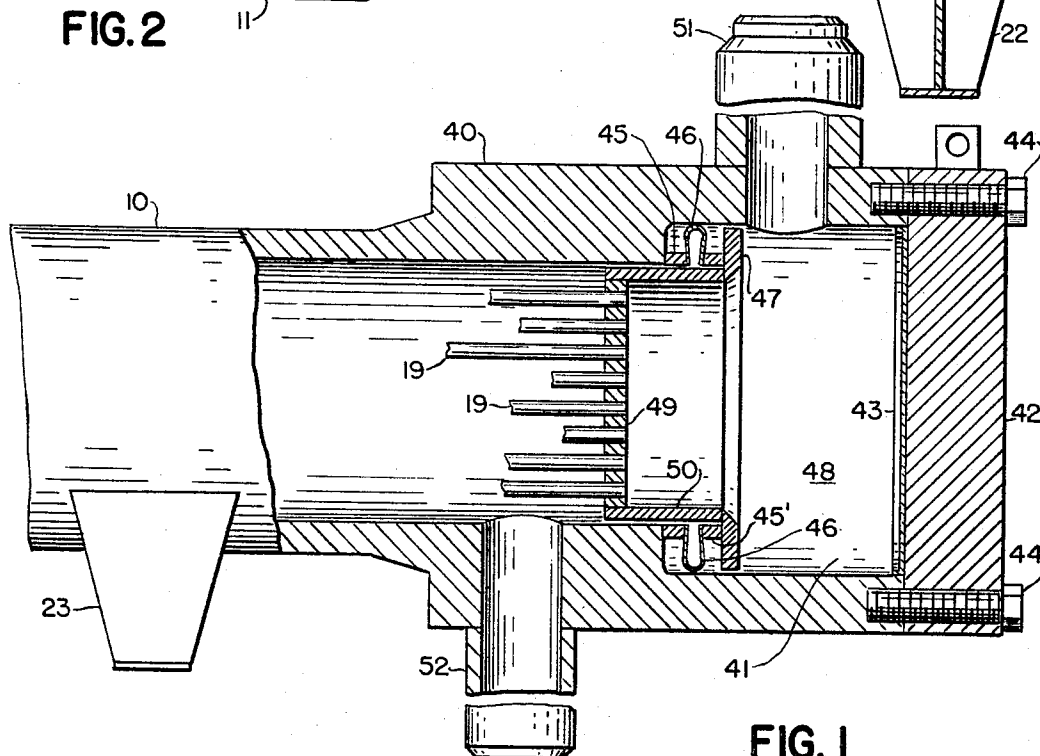


FIG. 1

INVENTOR:
JAMES W. BEVEVINO

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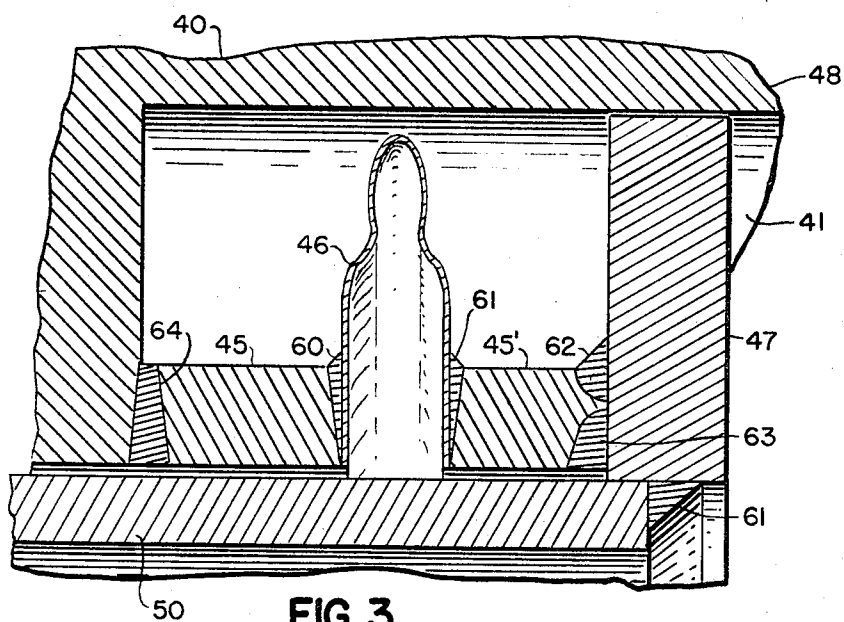
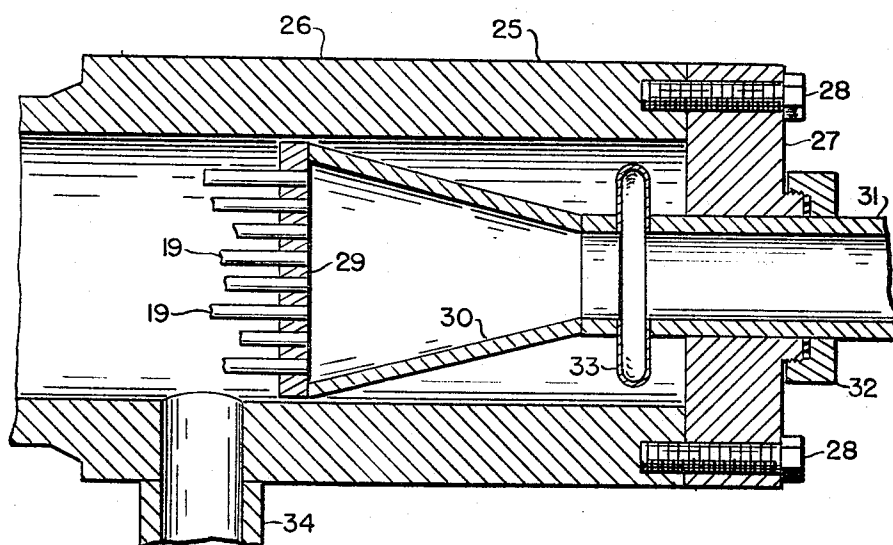
J. W. BEVEVINO

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INVENTOR:
JAMES W. BEVEVINO

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EXPANSION AND CONTRACTION MEANS FOR A HEAT EXCHANGER

James William Bevevino, Warren, Pa., assignor to Struthers Wells Corporation, a corporation of Maryland

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ABSTRACT OF THE DISCLOSURE

A shell and tube type heat exchanger having a longitudinal bore and first and second ends. The second end contains and terminates in an enlarged chamber. A first tube sheet is fixed in the first end of said shell. A tubular extension extends into the enlarged chamber and includes an outwardly extending expansion joint in the tubular extension. A tubular skirt extends through the extension and the outer end of the skirt is fixed to the outer end of the extension. A guide ring is fixed to the outer ends of the skirt and the extension is slidably disposed within the chamber. A second tube sheet is fixed to the inner end of the skirt and is slidably disposed within the bore.

This invention relates in general to heat exchangers, and, more particularly, to large capacity heat exchangers used in full scale industrial and chemical processes.

In large capacity heat exchanges having a cylindrical shell containing two spaced apart tube sheets with tubes extending therebetween, one fluid is passed through the tubes while the other fluid at a different temperature is passed through the shell about the tubes. This is accomplished by fixing one tube sheet within the shell and introducing fluid to pass through the tubes into the shell behind this fixed tube sheet. The second tube sheet cannot be fixed to a conventional shell as there may be a wide temperature difference between the fluid within the tubes and the fluid within the shell surrounding the tubes. Thus, the second tube sheet must be free to move within the shell as the tubes expand or contract within the shell.

For this reason, the second tube sheet is conventionally manifolded or covered by a transition piece connected to an inlet pipe. This inlet pipe must pass through some part of the shell and contain an expansion joint of some sort to allow motion of the second tube sheet. For this reason, in conventional heat exchangers of the type described, in addition to removing the end of the cylindrical shell, the transition piece must be cut from the second tube sheet. This is time consuming, sometimes difficult, and always costly.

A main object of this invention is to provide a more easily inspected and repaired large capacity heat exchanger.

Another object of this invention is to provide a more compact heat exchanger of a given capacity.

Many other objects, advantages, and features of invention reside in the particular construction, combination, and arrangement of parts involved in the embodiment of the invention and its practice as will be understood from the following description and accompanying drawing wherein:

FIGURE 1 is a side view of the end of a heat exchanger partially broken away in vertical section to show an expansion joint and tube sheet according to this invention;

FIGURE 2 is a side view of the other end of the heat exchanger of FIGURE 1 partially broken away in vertical section to show interior construction;

FIGURE 3 is an enlarged vertical section through a

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fragment of the heat exchanger of this invention showing the expansion joint and associated elements; and

FIGURE 4 is a longitudinal vertical section through an end of a conventional heat exchanger showing an expansion joint employed in a well known manner.

Referring to the drawing in detail, FIGURES 2 and 4 show the appearance of the ends of a conventional heat exchanger of large capacity. A cylindrical shell 10 is fabricated by butt welding large tubular sections. The end 11 has a terminal thickened wall 12 over which the cover 13 is secured by means of bolts 14, studs and nuts, or the like. A lifting lug 15 is provided on cover 13 and a gas tight diaphragm 16 is welded or otherwise secured in place under cover 13.

A ring 17 is welded in shell 10 and has the tube sheet 18 welded to it to fix it in place. Tubes 19, shown broken away, each have one end fixed in tube sheet 18 in a conventional manner. An inlet fitting 20 is welded to shell 10 to introduce flow through the tubes 19. An outlet fitting 21 is welded to shell 10 by the inner side of tube sheet 18 to receive flow through shell 10 about the tubes 19. Shell 10 rests on the supports 22 and 23.

As shown in FIGURE 4, a conventional heat exchanger has an end 25 with a thickened wall 26 over which is secured a cover 27 by means of bolts 28 or the like. A second tube sheet 29, in which the other ends of the tubes 19 are fixed, is slidably positioned in end 25 and has a fluid containing transition piece 30 welded over its outer end. An inlet pipe 31 extends through cover 27 and is sealed by means of a conventional packing device 32. Pipe 31 contains the expansion joint 33, which is welded in place to absorb longitudinal movement of the tube sheet 29 within shell 10 caused by the relative expansion or contraction of the tubes 19. An outlet fitting 34 is welded to end 25 to receive flow through the shell 10 about the tubes 19.

FIGURE 1 shows the construction of a heat exchanger according to this invention. The end 40 of a shell 10 has an enlarged outer chamber 41 over which the cover plate 42 and the sealing diaphragm 43 are fixed. The diaphragm 43 may be welded in position but the cover plate 42 is secured by means of bolts 44 or the like. A tubular extension 45 is welded to extend contiguously from the bore of shell 10 into chamber 41. Extension 45 contains an outwardly extending expansion joint 46. A guide ring 47 is welded to the end of extension 45 to extend outward and slidably contact the inner surface 48 of chamber 41. Tube sheet 49 is welded to a tubular skirt 50 which, in turn, is welded to the inner edge of guide ring 47.

As is further shown in FIGURE 1, an inlet fitting 51 is welded to end 40 to introduce fluid or gas into chamber 41 to flow through the tubes 19. An outlet fitting 52 is welded to shell 10 to receive flow through shell 10 outside the tubes 19. Thus, it may be seen that relative expansion of tubes 19 and the resulting longitudinal motion of tube sheet 49 is absorbed by the expansion joint 46. The ends of the tubes 19 may be inspected or repaired by merely removing cover 42 and the diaphragm 43. No packing for an inlet pipe is required. The inner end of the tube sheet skirt 50 slides within the bore of shell 10 while guide ring 47 slides within chamber 41.

As shown in FIGURE 3, extension 45 should be welded to the expansion joint 46 at 60 and 61 before insertion into the heat exchanger. Guide ring 47 is also welded to the outer portion 45' of extension 45 at 62 and 63 before insertion into chamber 41. The extension 45 with expansion joint 46 and guide ring 47 welded in place are inserted in chamber 41 and circumferentially welded in place from the inside at 64. The tube sheet 49 has the skirt 50 welded to it after which tube sheet 49

and skirt 50 are inserted through ring 47 to be welded in place at 61 to complete this portion of the assembly.

One heat exchanger built according to this invention cools converter gas entering the heat exchanger through fitting 51 and passing through the tubes 19 to emerge from fitting 20. The converter gas enters the heat exchanger at about 900° F. and is cooled therein to leave at 600° F. Lean synthesis gas enters shell 10 through fitting 21 at a temperature of 320° F. and is withdrawn through fitting 52 at 750° F. A temperature differential on this order may cause a longitudinal expansion in 28 foot long tubes 19 as much as ¼ inch. The shell 10 of this heat exchanger was designed to withstand internal pressures up to 2960 p.s.i. with a pressure differential between the tubes 19 and the shell 10 of as much as 400 p.s.i.

While this invention has been shown and described in the best form known, it will nevertheless be understood that this is purely exemplary and that modifications may be made without departing from the spirit and scope of the invention except as it may be more limited in the appended claims wherein what is claimed is:

1. A heat exchanger comprising, in combination, a shell having a longitudinal bore and first and second ends, said second end containing and terminating in an enlarged chamber, a first tube sheet fixed in the first end of said shell, a first cover fixed over the first end of said shell, a first fitting communicating with the bore of said shell between said first cover and said first tube sheet, a second fitting communicating with the bore of said shell by the inner side of said first tube sheet, a tubular extension extending from said bore into said enlarged chamber and terminating in an outer end, an outwardly extending expansion joint in said tubular extension, a

tubular skirt extending through said extension and having inner and outer ends, the outer end of said skirt being fixed to the outer end of said extension, a guide ring fixed to the outer end of said skirt and to the outer end of said extension and being slidably disposed within said chamber, a second tube sheet fixed to the inner end of said skirt, said second tube sheet and said inner end of said skirt being slidably disposed within the bore of said shell, a third fitting communicating with said enlarged chamber, a fourth fitting communicating with the bore of said shell by the inner side of said second tube sheet, a second cover fixed over said second end of said shell, and tubes fixed to extend between said tube sheets.

2. The combination according to claim 1 wherein said guide ring has inner and outer edges and said chamber has an inner surface, said outer edge of said guide ring sliding against the inner surface of said chamber, the inner edge of said guide ring being of greater diameter than said skirt, said outer end of said skirt being welded to said guide ring.

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ROBERT A. O'LEARY, *Primary Examiner*.

M. A. ANTONAKAS, *Assistant Examiner*.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,398,878

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Ronald G. Quiram et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 7, "aproximately" should read -- approximately --. Column 6, lines 14 and 15, cancel "and operatively connected to said air compressor,".

Signed and sealed this 3rd day of March 1970.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.

Commissioner of Patents