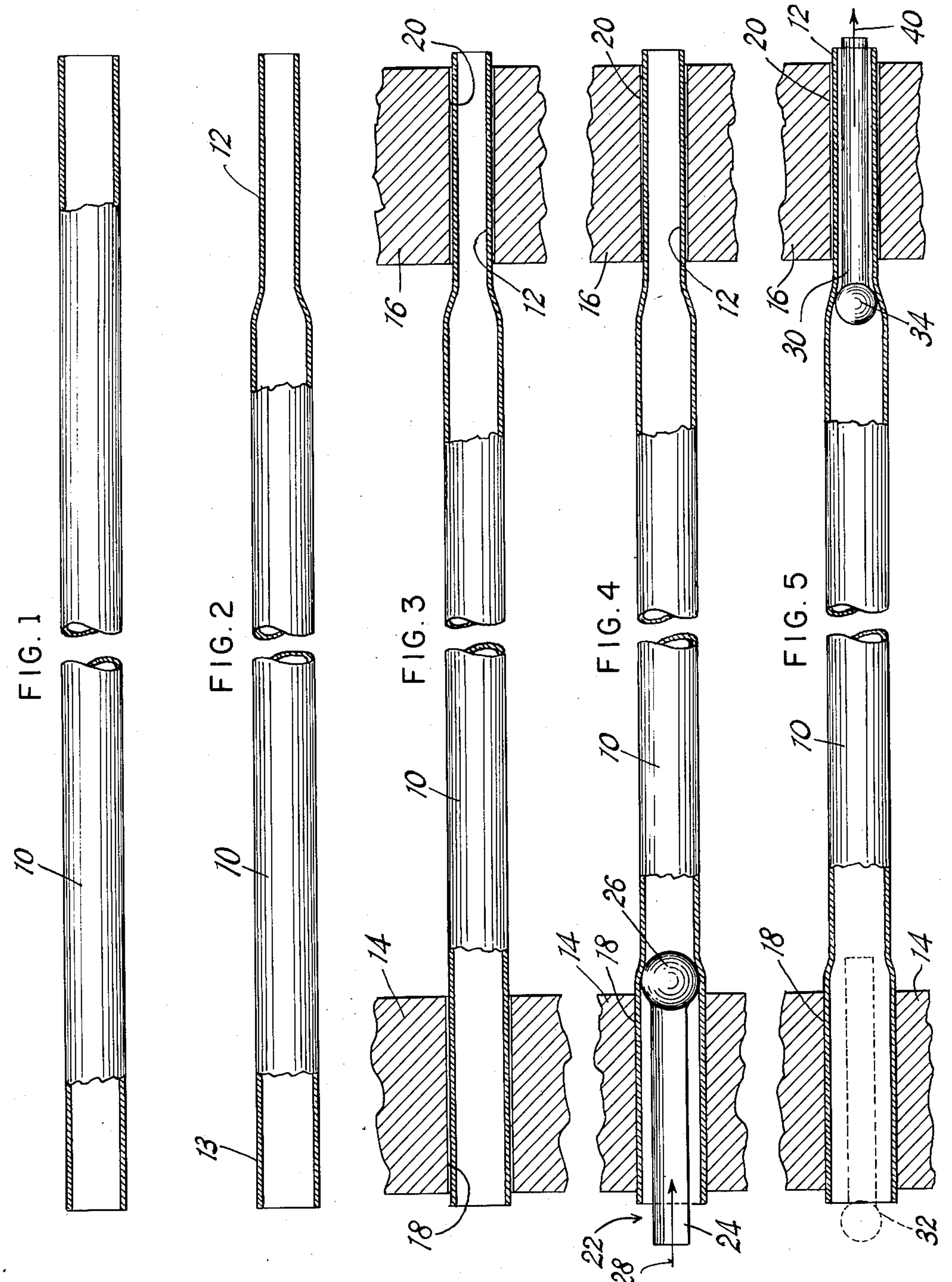
July 17, 1956 E. E. SCHOESSOW 2,754,573

METHOD OF MANUFACTURING FLUID HEAT EXCHANGE APPARATUS

Filed Aug. 15, 1952



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United States Patent Office 2,754,573 Patented July 17, 1956

2,754,573

METHOD OF MANUFACTURING FLUID HEAT EXCHANGE APPARATUS

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Application August 15, 1952, Serial No. 304,574

2 Claims. (Cl. 29—157.5)

The improvement of this invention relates to fluid heat exchange apparatus operable at substantial fluid pressures. The invention involves a method adapted for the manufacture of such apparatus, and the method is particularly concerned with the securement of tubes to the pressure parts of the apparatus in such a manner as to provide pressure tight connections without undesirably stressing the main parts of the tubes.

Specifically, the invention involves the swaging down of parts of the tubes to form, for each tube, one tube seat portion of a diameter less than the diameter of the remainder of the tube, the formation of tube seats in the pressure parts to slidably receive the swaged down tube seat portions and other tube seat portions of larger diameter, the fitting of the tube seat portions in their proper tube seats in the pressure parts, the expanding of a larger diametered portion of a tube into its tube seat, and then the expanding of the swaged down tube seat portion of the same tube into its fitting tube seat by expanding action which does not involve tube metal flow toward the previously expanded tube seat portion of the same tube. This method permits the use of a ball drift expander of one diameter for the larger diametered tube seat portion, the passage through the unswaged parts of the tube of a smaller diametered ball drift expander for expanding of the swaged down tube seat portion by movement in the same direction (longitudinally of the tube) as the move ment of the first expanding operation. This procedure permits tube metal flow in the same direction for both expanding operations effected in each tube, and thereby prevents undesirable tube stressing which might result in the bowing of the main parts of the tubes or the impressing of forces tending to disturb the operative positions of the pressure parts (or tube sheets).

The illustrative method is particularly advantageous, in the manufacture of the pertinent type of heat exchange apparatus by incremental expanders which effect tube metal flow in one direction away from the starting point of the expanding operation, and the type of expander involved may be other than a ball drift expander.

The method of the invention is particularly and concisely set forth in the subjoined claims, but, for a better understanding of the invention, its uses and advantages, recourse should be had to the following description which refers to similarly characterized parts in the accompanying drawings.

In the drawings:

Fig. 1 shows a heat exchange tube to be secured in pressure tight relationship to spaced pressure parts having tube seats therein;

Fig. 2 is an elevation of a tube with its ends shown in section to illustrate the step of swaging down one end of the tube to form a tube seat portion of a diameter less than the diameter of the remainder of the tube;

Fig. 3 is a section (with a part of the tube in elevation) illustrating the step of fitting the tube into tube seats in opposed tube sheets of pressure parts, with the swaged down tube seat portion fitted into a tube seat of a diameter less than the diameter of the tube seat receiving the other end of the tube;

Fig. 4 is a view similar to Fig. 3, but showing the final part of the action of a ball drift expander in expanding the larger diametered tube seat portion into its fitting tube seat; and

Fig. 5 is a view similar to Fig. 3, but showing a ball drift expander about to become effective on the swaged down tube seat portion, after having been passed through the unswaged portions of the tube.

Starting with a tube **10**, of uniform diameter, the practice of the invention involves the swaging down of the right hand end of the tube to form the smaller diameter tube seat position **12**. The tube is then operatively disposed relative to the walls **14** and **16** of pressure parts (such as drums, headers, or the tube sheet walls of the other pressure chambers). The wall **14** has previously been drilled to form the tube seat **18** to slidably fit the left hand end of the tube, and the wall **16** has been drilled to form the smaller diameter tube seat **20** to slidably receive the swaged down tube seat portion **12**.

Next, a ball drift expander is utilized to expand the larger diametered tube seat portion **13** into the tube seat **18**. This expander is shown as having a stem **24**, unitary with a head or ball **26** of such a diameter, slightly larger than the inside diameter of the tube, that as the expander is forced in the direction of the arrow **28**, into the tube, the left hand end of the tube (or its larger diametered tube seat portion) is expanded tightly into the tube seat **18**. This action, to secure the desired pressure tightness, stresses the metal of the tube seat, while causing tube metal flow in the direction of advance of the expander.

Fig. 4 shows the expander **22** at the end of its effective expanding operation, at a position close to the plane of the right hand surface of the wall **14**. When the expander has reached this position it is withdrawn from the tube, and another similar expander **30** is passed into and along the tube from the dotted line position **32** of Fig. 5 to the full line position indicated near the opposite end of the tube. This expander has a head or ball **34** of such a diameter, slightly larger than the inside diameter of the swaged down tube seat portion **12**, that its passage through that tube seat portion **12** in the direction of the arrow **40** will exert enough expansive force to stress the tube seat **20**, while causing metal flow in the same direction as the metal flow of the expanding operation at the other end of the tube.

When the tube seat walls **14** and **16** are formed by fixed tube sheets, or fixed headers, a large number of parallel and closely spaced tubes may be secured in pressure tight juncture with those pressure parts without placing the tubes under such compressive stresses as might otherwise be created. For example, if both ends of each tube were protractively expanded (that is, by action advancing from a tube end toward a point midway of the length of the tube) the main part of the tube would be placed under substantial compressive stresses, and if the magnitude of these stresses were great enough the tubes might be bent so as to interfere with their proper operative spacing, or the connected pressure parts might be placed under undesirable stresses. In this connection it is to be noted that the illustrative method involves protractive expanding at the left hand end of the tube, and retractive expanding at the opposite end of the tube. Also, both expanding operations are of the incremental type, with the effective force of the expanding operation active, at any one instant, over a very small increment of the total surface of the tube seat, or the total surface of the tube seat portion to be expanded.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form and mode of operation of the invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. In a method of securing tubes in pressure tight relationship to spaced pressure parts to be connected by the tubes, swaging down one end only of each tube to form a tube seat portion of a diameter less than the remainder of the tube, positioning the opposite ends of each tube into fitting tube seats in the pressure parts, protractively expanding the larger diametered end of an individual tube into its tube seat, passing into the tube from its expanded end a solid head expander of larger diameter than the inside diameter of the swaged down tube seat portion, and therewith retractively incrementally expanding the swaged down tube seat portion of that tube into its tube seat, and repeating the above specified sequence of operations for each of the remaining tubes.

2. In the manufacture of a fluid heat exchange unit

having a multiplicity of small diameter tubes connecting pressure parts having a pair of tube seats of different diameters therein for individual tubes, reducing the diameter of one portion of each tube near one end thereof, fitting the tubes into their corresponding tube seats and in connecting relationship to the pressure parts, fixing the unreduced portion of a tube in its fitting tube seat and in pressure tight relation to its associated pressure part, retractively and incrementally ball drift expanding a reduced portion into its fitting tube seat by solid ball drift action initiated through the fixed portion and proceeding through the reduced end portion and out of the tube at the adjacent tube end, and repeating the above specified operation for succeeding tubes.

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