

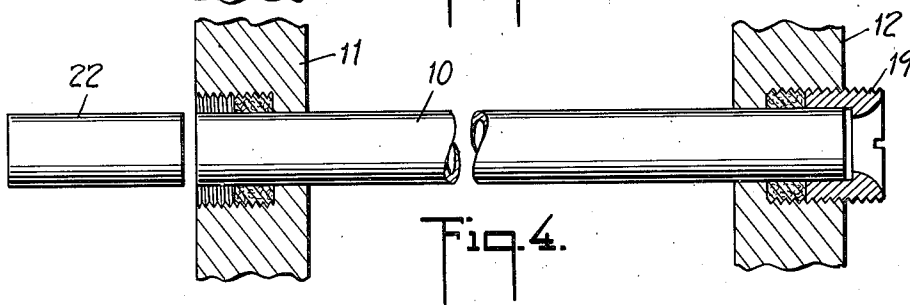
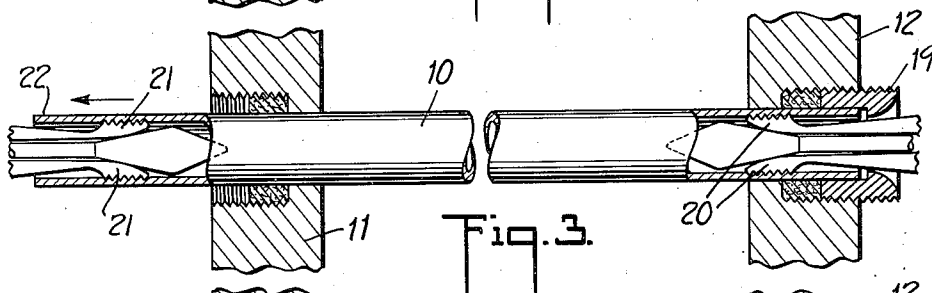
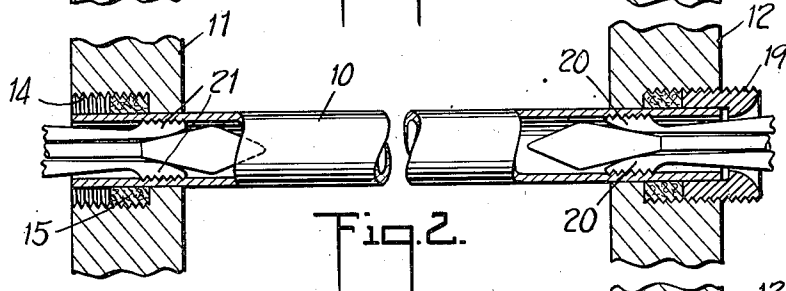
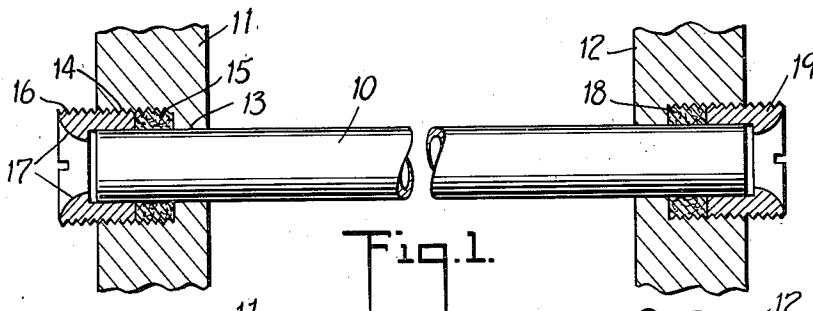
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METHOD OF TUBE RENOVATION

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METHOD OF TUBE RENOVATION

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4 Claims. (Cl. 29—157.4)

My present invention relates generally to apparatus, such as heat exchange apparatus, wherein a bundle of tubes is supported between spaced tube sheets; and has particular reference to a method of renovating such tubes.

A surface condenser may serve as a typical example of the kind of apparatus with which my present method is to be practiced. In it, there are long metal tubes supported in substantially parallel relation between spaced tube sheets. The tubes are sometimes twenty-five feet in length, or longer, and there may be thousands of them in a single apparatus. Cooling water passes through these tubes, each tube having an inlet end and an outlet end associated in fluid-tight relation to one of the tube sheets. Sooner or later, these tubes corrode, or become otherwise worn or impaired. Heretofore, it has been the general practice to withdraw the tubes entirely, and to replace them with new tubes, a procedure which is quite lengthy and expensive.

The impairment of the tubes is most commonly due to corrosion. Corrosion is due primarily to chemical and electrolytic causes, and can be directly attributed in large measure to the air that is entrained with the cooling water. Where salt water is used as the cooling medium, as in marine installations, this condition is aggravated.

It is known that, generally speaking, the worst corrosion takes place at the inlet end of each tube, i. e., where the cooling water enters the tube. This is due to the fact that the water entering a tube from the inlet water box follows the well-known rules relating to the flow of liquids through orifices, and in the ordinary installation a vena contracta is formed within the tube end, creating a vacuum around it, and causing the entrained air to be drawn directly into contact with the metal of the tube at that region. As the corrosion progresses, the tube wall becomes thinner and thinner, and ultimately fails entirely. The major portion of the tube, however, removed from the inlet end portion, is in most cases of adequate thickness to withstand many more years of use.

My present invention aims to effect a renovation of such tubes by the elimination from each tube of only the corroded region at the end portion of the tube, without sacrificing the potential usefulness of the major portion of the tube. I have found it possible to accomplish this object by stretching each tube in situ, to effect a permanent elongation thereof, thereby permitting the corroded end portion to be severed from the tube,

and permitting the remaining portion of the tube to continue in service.

More particularly, my invention comprises the steps of gripping the tube internally at each end, then holding one end against movement and pulling the other end longitudinally to stretch the tube, and then cutting away the corroded portion.

These procedural steps are most expeditiously carried out with the aid of two pulling devices, such as those described in my prior patents, Nos. 1,717,487 and 1,964,023.

The present procedure is of such a character that, either before or after the actual stretching operation, renovations of packing, at one or both ends of the tube, may be conveniently carried out. As a result, an apparatus subjected to the present mode of treatment may be restored to a thoroughly renovated condition, with the prospect of a long additional useful life, at a relatively small expense and in a minimum period of time during which the apparatus is inactive.

I achieve the foregoing objects and such other objects as may hereinafter appear or be pointed out, in the manner illustratively exemplified in the accompanying drawing, wherein:

Figure 1 is a fragmentary cross-sectional view through a typical apparatus, showing a single tube supported at its ends in fluid-tight association with spaced tube sheets;

Figure 2 is a view similar to Figure 1 showing one way of initiating the present procedure with the aid of tube pulling devices;

Figure 3 is the same as Figure 2, showing the relationship of the elements after the tube has been stretched; and

Figure 4 is a similar view showing a further step in the procedure.

For the purpose of explaining my invention, I have chosen to illustrate a typical tube 10 whose ends are associated with the spaced tube sheets 11 and 12. Merely by way of example, I have shown each tube end associated in fluid-tight relation to the tube sheet, by means of a conventional packing box. Thus, the tube sheet 11 is provided with an opening 13, extending about one-third through the tube sheet from the inner surface thereof, this opening having substantially the same diameter as that of the tube 10. This opening communicates with a larger internally threaded opening 14 which extends all the way to the outer surface of the tube sheet. A mass or winding of suitable packing 15 is accommodated within the inner portion of the opening 14, and an externally threaded ferrule 16 is removably screwed into the opening 14 to compress

the packing 15 and hold it in place. The ferrule is tubular in cross section, its inner diameter being substantially the same as the outer diameter of the tube 10. The outer end of the ferrule is, of course, open, and is usually provided with the converging walls 17 which facilitate the flow of water through the tube 10.

The other end of the tube 10 may be similarly associated in fluid-tight relation to the tube sheet 12 by means of the packing 18 and the ferrule 19.

It will be understood that many thousands of tubes, such as the tube 10, may be arranged between the tube sheets 11 and 12, and that these tubes may be as much as twenty-five feet in length, or longer. To explain my invention, however, it is deemed desirable to show only a single tube. The thickness of the tube wall will depend upon the kind of tube, the material of which it is made, its length, and the general type of apparatus in which it is used. In any event, it is to be understood that the wall thickness, as shown in the present drawing, is not intended to be drawn to scale, nor are the other elements or parts intended to be accurate scaled representations of any particular kind or style of tube or apparatus.

For the present purpose, it will be assumed that the tube 10 is one of many which are supported by the spaced tube sheets of a surface condenser, and that the left-hand end of the tube is the inlet end through which cooling water enters the tube. It is this end portion of the tube which suffers the worst corrosion, and which ultimately becomes so impaired that the tube needs renovation. In the accompanying drawing, one way of carrying out my present invention is illustrated.

First, the tube is internally gripped at each end. At the right-hand end, it is preferable to employ a device of the character shown in my Patent 1,717,487, except that the gripping teeth 20 are of the serrated nature shown in the present drawing, and shown more fully in my earlier Patent 1,964,023, in which patent they are designated by the reference numeral 13.

The teeth 20 are inserted to such an extent that when they are forced outwardly to grip the tube, they will be substantially aligned with the inner portion of the opening in the tube sheet 12, whereby a firm grip upon the tube may be obtained without distorting the tube. It will be observed that this internal engagement of the tube may be effected, if desired, without removing the ferrule 19.

A similar internal grip is effected at the inlet end of the tube 10, but in this case it is preferable to employ a pulling device of the character shown in my earlier Patent 1,964,023. In the present drawing, the teeth of such an apparatus are designated by the reference numerals 21. At the inlet end of the tube, however, it is first necessary to remove the ferrule 16.

The stroke of the pulling device at this end of the tube is then adjusted to the desired degree, and when the pulling device is operated, the tube is forcibly stretched as indicated in Figure 3. This stretching is accomplished by holding the right-hand or outlet end of the tube against movement, by means of the teeth 20, while permitting the pulling device at the left to stretch the tube longitudinally. Depending upon the stroke to which the pulling device has been preliminarily adjusted, the tube may be stretched by any desired amount up to about six to eight inches, or possibly

more. The stretching operation effects a permanent elongation of the tube, during which time, obviously, the wall thickness of the tube is slightly reduced. However, in carrying out the present invention, this reduction in wall thickness is entirely negligible in amount, being usually less than one thousandth of an inch.

If the tube is not sufficiently elongated by the first pulling operation, the procedure may be repeated by cutting off the projecting end of the tube and reinserting the pulling device. Usually, however, one stroke of the pulling device is sufficient to effect the desired elongation, and in the present drawing this single step of elongation is assumed to be adequate. This means that the projecting portion of the elongated tube designated by the reference numeral 22 contains within itself all of the severely corroded region.

The gripping device having been removed, the next step illustrated in Figure 4 is to sever the end portion 22 from the body of the tube. This may be conveniently accomplished with the aid of a tube cutting device of the character shown in my earlier Patent No. 1,883,453. The cut is preferably accomplished substantially in the plane of the outer surface of the tube sheet 11.

The final step is to replace the ferrule 16.

In actual practice, assuming that the tube end portion 22 is badly corroded, the thickness of this tube portion will be much less than that shown 30 in the present drawings. It will be understood, however, as hereinbefore stated, that no attempt has been made to show, in the present drawings, the relative thicknesses of the tube wall in the badly corroded and non-corroded regions.

The present procedure lends itself readily to modifications, some of which will be illustratively alluded to.

It may be desirable, for example, to effect a thorough cleaning of the packing box in the tube sheet 11 before replacing the ferrule 16. One easy way in which this can be accomplished would be by first cutting the tube at or near the base of the packing box, in the tube sheet 11. With the short tube end removed, the interior of the packing box would then be conveniently accessible for cleaning purposes, and after the cleaning operation, the tube would be internally gripped and stretched as hereinbefore described and illustrated.

Similarly, if it is deemed desirable to effect a thorough cleaning of the packing boxes in both tube sheets, the procedure might be somewhat as follows. The tube would first be pulled toward the inlet end, but without stretching it, thereby leaving the packing box at the outlet end available for cleaning. The tube could then be driven back to an extent which leaves the packing box in the tube sheet 11 available for cleaning, the tube could then be shifted to its normal position between the tube sheets, and internally gripped at both ends and subjected to the stretching operation hereinbefore described and illustrated.

While the severance of the end portion of the tube usually takes place at the inlet end, it will be understood that the opposite end of the tube could similarly be severed, if it were deemed desirable to do so.

Where the tube ends are "rolled" into fluid-tight association with the tube sheets, thereby dispensing with packing boxes entirely, the present procedure is carried out in the same way, and is, in fact, somewhat simpler because no packing or packing renovation need be taken into account.

In general, it will be understood that changes

in the details, herein described and illustrated for the purpose of explaining the nature of my invention, may be made by those skilled in the art without departing from the spirit and scope of the invention as expressed in the appended claims. It is, therefore, intended that these details be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, and illustrated its use, what I claim as new and desire to secure by Letters Patent is—

1. A method of renovating a tube of a heat exchange apparatus of the character described, in which the tube is mounted at opposite ends in spaced walls and where an end portion of the tube has become impaired, which consists in holding the good end against movement and stretching the tube in situ while the tube is in place between the spaced walls to effect a permanent elongation thereof with the impaired end portion projecting from the adjacent wall, and severing the impaired end portion.

2. A method of renovating a tube of a heat exchange apparatus of the character described, in which the tube is mounted at opposite ends in spaced walls and where an end portion of the tube has become impaired, which consists in gripping the tube internally at each end, holding the good end against movement and pulling the other end while the tube is in place between the spaced walls to stretch the tube in situ into a permanent elongation thereof with the impaired end portion projecting from the adjacent wall, and then severing the impaired end portion.

3. A method of renovating a tube of a heat exchange apparatus of the character described, in which the tube ends are in fluid-tight association with spaced tube sheets and in which an end portion of the tube has become impaired, which consists in gripping the tube internally at each end while the tube is in place between said spaced sheets, holding the good end against movement relative to one of the sheets and pulling the other end to stretch the tube in situ into a permanent elongation thereof beyond the other sheet, then severing the impaired end portion and restoring the desired length to the tube, and finally reestablishing a fluid-tight association between tube and tube sheet at the severed end.

4. A method of renovating a tube of a heat exchange apparatus of the character described, in which the tube ends are in fluid-tight association with openings in spaced tube sheets and in which an end portion of the tube has become impaired while the other end remains good, which consists in creating an outward expanding action in the good end of the tube against the surrounding opening in the adjacent tube sheet holding said good end of the tube against lengthwise movement relative to said adjacent tube sheet and pulling the impaired end portion to stretch the tube into a permanent elongation thereof beyond the other tube sheet, then severing the impaired end portion and restoring the desired length to the tube, and finally reestablishing a fluid-tight association between the tube and tube sheet at the severed end.

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