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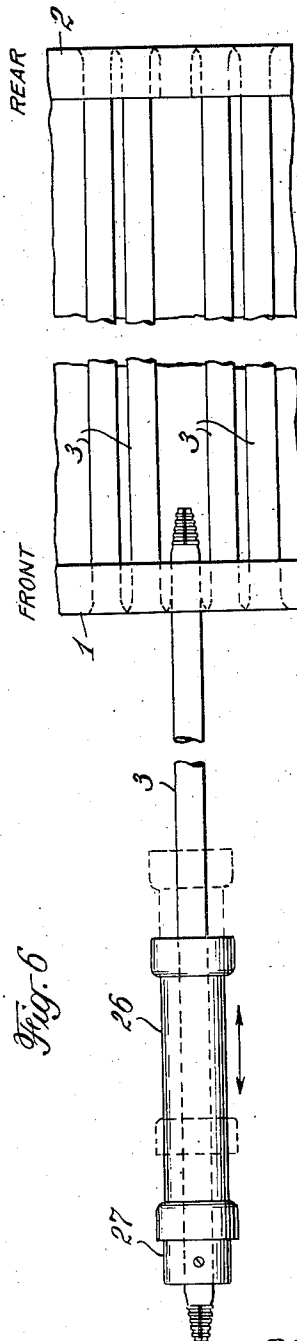
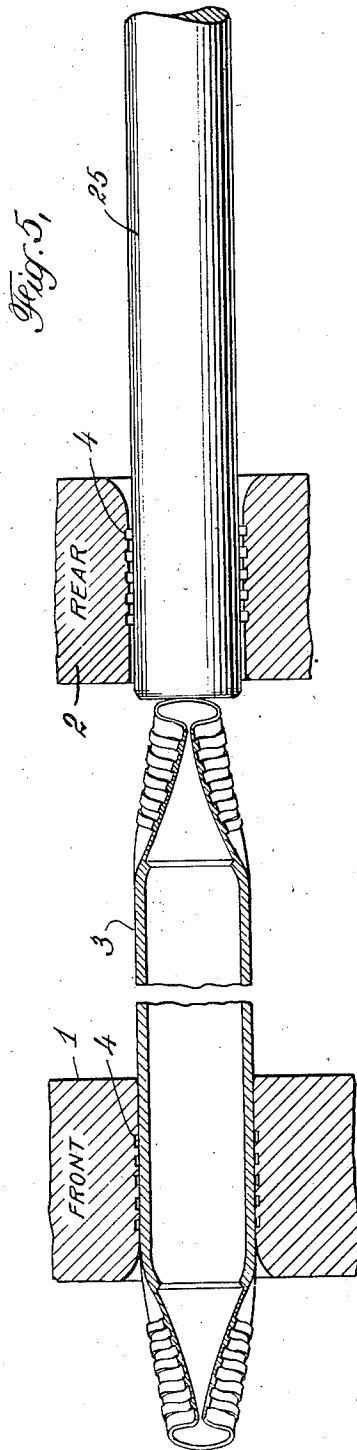
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METHOD OF REMOVING DEFECTIVE TUBES FROM TUBE SHEETS

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METHOD OF REMOVING DEFECTIVE TUBES
FROM TUBE SHEETS

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1 Claim. (Cl. 29—157.4)

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This invention relates to an improved method of removing defective tubes from tube sheets, such as boilers, heat exchangers or the like, and has for its object a method of removing such tubes which can be carried out rapidly by hand by repair men of ordinary skill and without danger of damage to the tube sheets, whereby a defective tube may be removed and a new tube installed with minimum loss of time in the operation of the apparatus.

It has heretofore been the universal practice to cut or chip away the ends of the tube which are expanded in the tube sheet by means of ordinary machinists' tools such as cold chisels, or sometimes blow torches, the operation being slow and tedious and frequently resulting in damage to the tube sheets, thereby necessitating a re-grooving of the tube sheets.

By my improved method, which can be carried out with a few special tools of simple design, the operation of removing the tube can be carried out in a fraction of the time heretofore necessary according to the procedure customary with ordinary tools. In addition the danger of damaging the tube sheet is completely obviated. That is to say, the special tools are so designed that no special skill is required for their rapid and efficient use and even in unskilled hands there is no danger of injuring the tube sheet.

In the accompanying drawings I have illustrated the successive steps taken in carrying out my improved method of procedure.

In said drawings:

Figure 1 shows both tube sheets in cross-section, the connecting tube the middle portion of which is broken away and the special tool used in carrying out the first step in the process;

Fig. 2 is a similar view showing both ends of the tube at the conclusion of the second step in the process and the tool for carrying out the second step;

Fig. 3 shows in cross-section the third step in the operation and the tool for performing this step. These steps are performed on both ends of the tube, and may be performed simultaneously by two operators, or successively;

Fig. 4 is a sectional view on line 4—4 of Fig. 3;

Fig. 5 illustrates the final step in the process; and

Fig. 6 illustrates an expedient that may be resorted to if the loosened tube tends to stick in the tube sheet while being withdrawn.

Referring to the drawings, 1 and 2 indicate, respectively, the front and rear tube sheets of a boiler or heat exchanger. 3 indicates a section

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of tubing, usually of copper or similar non-corrosive metal. In the customary construction of such apparatus the holes in the tube sheets in which the tubes are mounted are grooved as shown at 4, and the tubes are expanded into the grooves as shown, the ends of the tube being also flared outwardly or expanded to seat against the rounded and flaring surface of the holes at the outer faces of the tube sheets. The structure illustrated is that commonly employed for high pressure tube-and-shell apparatus. In many uses to which tube-and-shell apparatus is put, it is highly essential that there is no weakening of the tube walls, as a burst tube in the operation of the apparatus may result in very serious damage. It is customary in using the apparatus to shut down periodically and test the strength of the tubes by subjecting them individually to high pressure. When a tube is found to be defective—that is to say, if it ruptures or stretches under the applied pressure—the defective tube must be removed and replaced with a new tube.

This type of apparatus may have the ends of the tubes so closely set together in the tube sheets as to be impossible for more than a limited number of mechanics to be engaged in the testing and replacing of the tubes in one piece of apparatus. Hence, if any substantial number of tubes are found defective, the time that the apparatus must be shut down is greatly increased and the loss due to the shut-down of the plant amounts to a great deal more than the cost of replacing the tubes. My improved process cuts down the time required for replacing defective tubes in apparatus of this kind to a fraction of the time otherwise required by present known methods.

The first step in the operation of removing the tubes as illustrated in Fig. 1 is carried out by means of an annular cutter such as illustrated at 10. The diameter of the cutter is just equal to the external diameter of the tube, and its purpose is to cut away the flared ends of the tube in the manner illustrated.

The cutter 10 has an annular bore extending inwardly from its cutting face, as indicated at 11 in dotted lines in Fig. 1. Supported in this bore is the stem of a guide member 12 of an external diameter to fit snugly in the tube to be removed. A pin 13 threaded through the wall of the cutter 10 near the end of the stem 11 engages a groove in the stem near its end to hold the guide 12 in place in the cutter while permitting relative rotation of the cutter and guide, as well as a limited relative longitudinal

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movement. The guide 12 centers the cutter with respect to the tubes so that the cutter will remove the flared end of the tube without damaging the surrounding metal of the tube sheets.

After both flared ends of the tube are cut away 5 to the extent illustrated in Fig. 1 the tube is bored out in the manner shown in Fig. 2. The major portion of the tube is bored away, leaving merely a thin wall which may be readily deformed. The tool for this work is an annular 10 cutter 14 whose outer diameter is slightly less than the outer diameter of the tube. The cutter 14 is also provided with a guide member as shown at 15, having an extended stem 16 extending into 15 a central bore of the cutter for the purpose of centering the cutter with respect to the tube and insuring its movement axially of the tube during the cutting operation. By this arrangement the wall of the tube may be reduced to paper thin- 20 ness without danger of cutting through the tube and damaging the tube sheet.

The guide 15 is held in place in the bore of the cutter 14 by means of pin-and-groove connections of the same kind as provided for the cutter 10.

The cutter 14 is preferably provided with an adjustable collar 17 which by means of setscrew 18 may be positioned on the cutter in such position as to contact the outer face of the tube sheet when the inner portion of the tube has been cut 30 away to a sufficient extent lengthwise of the tube. As shown in Fig. 2 it is preferable to cut away the wall of the tube in the manner described to a distance somewhat beyond the innermost groove in the tube sheet, but not quite to 35 the inner face of the tube sheet. In Fig. 2 both ends of the tube are shown as cut away to the desired extent.

The next step in the operation of removing the tube is accomplished by means of a special 40 tool illustrated in Fig. 3. This tool consists of a round bar having a diameter substantially equal to the outer diameter of the tube. The end of the bar is cut away to the cross-section shown in Fig. 4. That is to say, the bar is cut away 45 except for a tongue or point 20 whose outer surface is curved on the same radius as the outer surface of the tube, and which has a rib 21 projecting radially inward from the tongue 20, the rib being rounded as shown to force the thin walled portion of the tube inward in the manner shown without rupturing the metal. The cut- 50 away end of the tube is tapered to a point at the end which is thin enough to be readily inserted between the tube and tube sheet at the point where the flared end was cut away in the first step of the process as above described. The tool 19 is driven between the cutaway portion of the tube and the adjacent surface of the tube sheet in the manner shown in Fig. 3 at two 60 points diametrically opposite to thereby bend the thin walled section of the tube inward into a figure eight configuration, as illustrated, thereby freeing the ribs on the outer surface of the

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tube from the corresponding grooves in the tube sheet.

Each of the operations above described is performed on each end of the tube, thereby freeing the tube completely from the tube sheets so that it may be withdrawn from either direction.

In order to facilitate the withdrawal of the tube a punch bar 25 is driven against the bent-in end of the tube section and the tube thereby projected through the other end a sufficient distance to be taken hold of and withdrawn. If the tube tends to stick in the tube sheet when it is attempted to pull the tube through the tube sheet, as may occur if the tubes have any deposit of scale or corrosion, the withdrawal of the tubes can be facilitated in the manner shown in Fig. 6. As here shown a collar 26 of an inside diameter large enough to move freely on the tube is slipped over the free end of the tube and a second collar 27 is then fastened to the end of the tube, as for instance by means of a suitable screw or pin. The collar 26 is of sufficient mass to serve as a hammer and by driving against the fixed collar 27 the tube can be driven out. If the tube is a long one of small diameter the collar 27 may be moved along the tube toward the tube sheet as the tube is withdrawn so that the tube will not be bent downward by the weight of the hammer.

The whole operation of removing the tube can be carried out by an ordinary mechanic in very few minutes, leaving the tube sheets ready for the immediate replacement of the new tube.

As stated above, the special tools illustrated need not in every instance be used for carrying out the process steps, but I have found the carrying out of the process is greatly facilitated by using such tools and injury to the tube sheet is completely avoided.

It will also be understood that my invention is not limited to the details of procedure herein described but may be variously modified within the scope of the appended claim.

In the appended claim the term "boiler" is used in the generic sense to define any form of heat exchange apparatus comprising tubes and tube sheets and not in the limited sense of steam generating apparatus.

I claim:

The method of removing tubes having flared ends from boiler tube sheets wherein the tube has ribs in grooves in the tube sheet, which comprises cutting the tube sufficient to enable removal of its entire flared end portion, then cutting away the inner wall of the tube to a point adjacent the inner wall of the tube sheet leaving a thin walled section having ribs in the grooves of the boiler tube sheet, and then collapsing the thin walled end section of the tube to release the ribs from the grooves in the tube sheet.

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