Feb. 3, 1931. S. BROWN 1,790,897

HEAT EXCHANGER

Filed Jan. 12, 1928 2 Sheets-Sheet 1

Fig. 1,

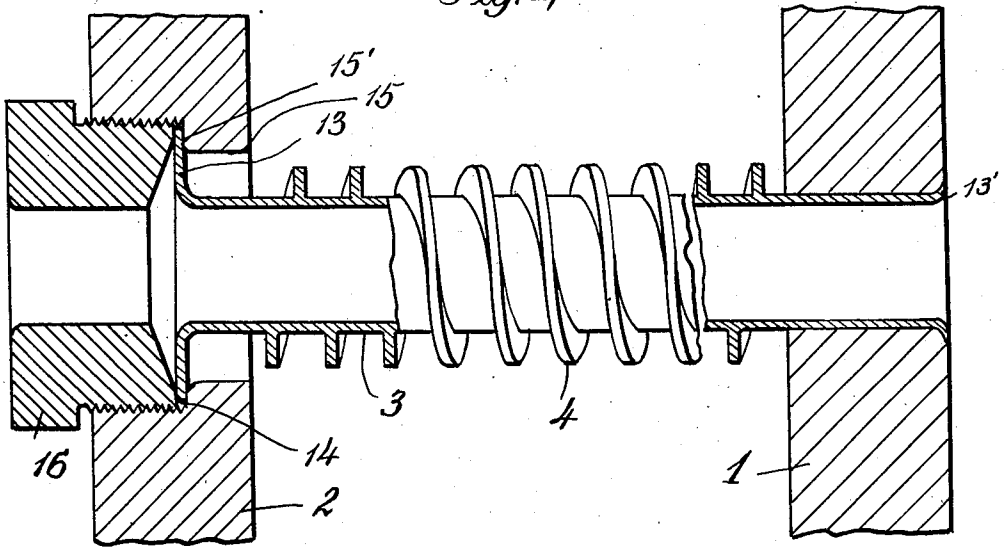
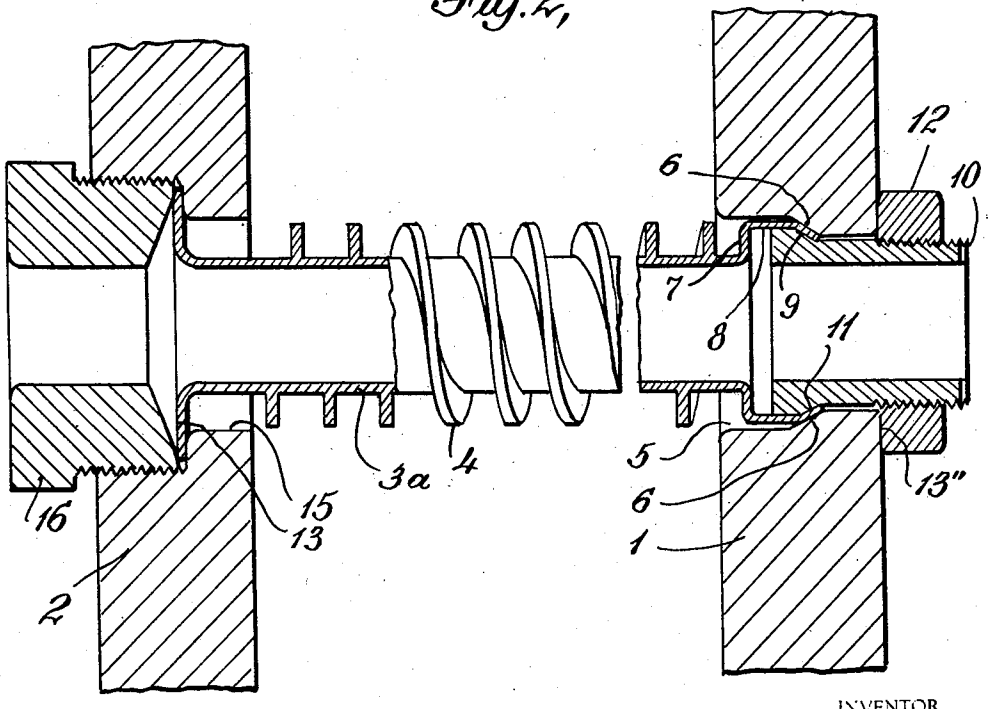


Fig. 2,



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Fig. 3,

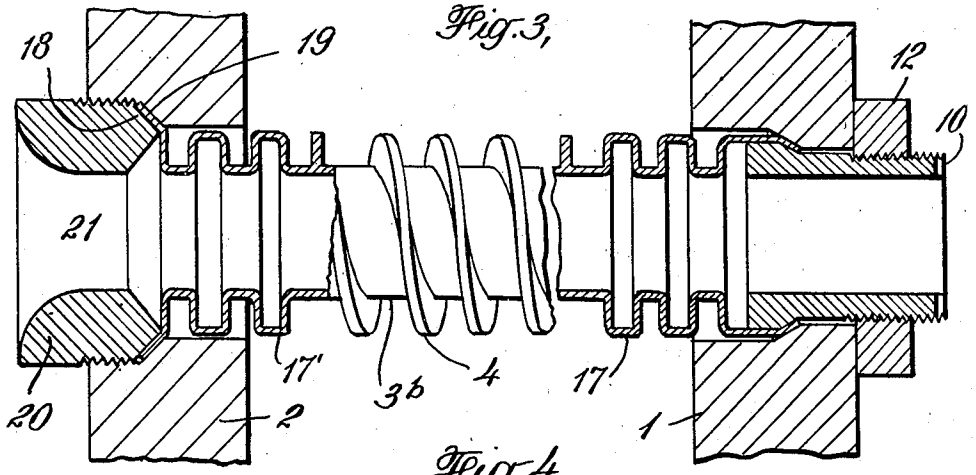


Fig. 4,

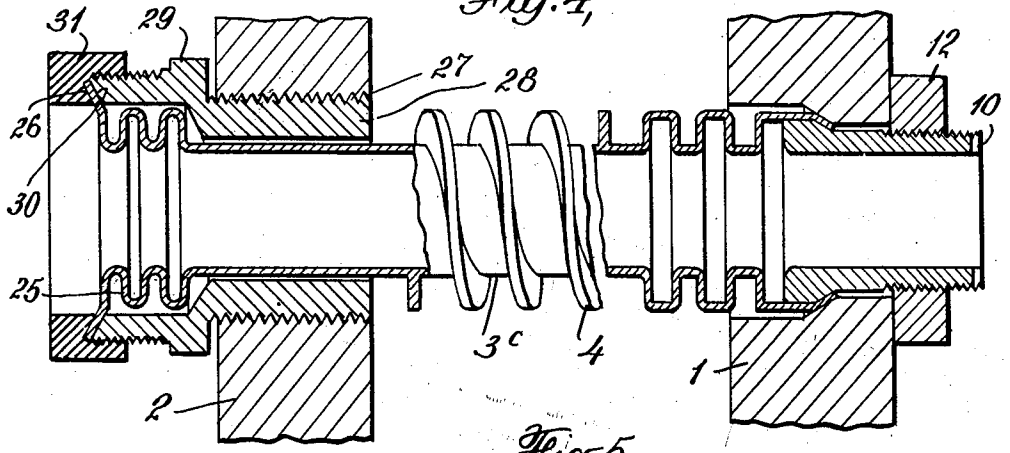
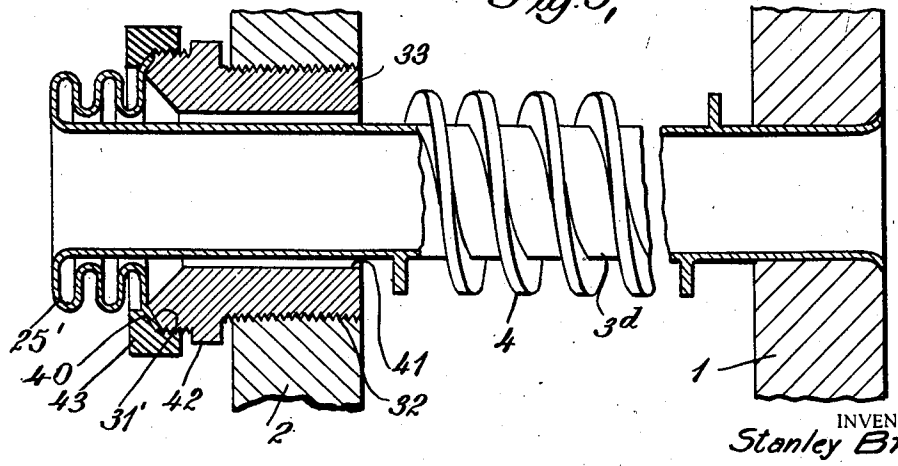


Fig. 5,



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UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

Application filed January 12, 1928. Serial No. 246,120.

This invention has to do with heat transfer apparatus such as air coolers, condensers, feed-water heaters, and the like.

Apparatus of the type to which this invention relates comprises a plurality of cooling tubes extending between supporting tube sheets to which the tubes are rigidly secured —the tubes being adapted to convey fluid, either liquid or gaseous, to which or from which heat is to be transferred, from or to the medium surrounding the tubes, respectively.

One of the objects of this invention is to provide simple and inexpensive, but reliable, structural arrangements whereby lengthwise contraction and expansion of the cooling tubes, due to temperature changes, is automatically absorbed in such a manner as to prevent any undue stresses being imposed upon the supporting tube sheets or upon the joints through which the tubes are secured to the tube sheets.

Another object of the invention is to provide a structure wherein tubes provided with external radial projections, such as spiral fins, may be secured to the tube sheets in such a manner as to permit of individual removal of the tubes without disturbing the tube-sheets or the other tubes.

Still another object of the invention is to provide a mechanical arrangement whereby both of the aforementioned objects may be accomplished in one and the same structure—that is to say, a structure in which the lengthwise expansion and contraction of the tubes is automatically absorbed without undue stress on the tube sheets, and in which tubes provided with radial projections are individually removed with ease and without damage to the tubes or tube-sheets.

A further object of the invention is to construct an air cooler having fixed-headers and straight tubes in which the ends of the tubes are rigidly secured to the tube-sheets so as to avoid leakage, instead of being secured in the tube sheets by the use of packed or sliding joints.

Several forms, all embodying the present invention and accomplishing the aforementioned objects, are illustrated in the accompanying drawings and described in detail hereinafter, but the invention may take any form included within the scope of the subjoined claims.

In the drawings,

Fig. 1 is a sectional view, partly in elevation, of an advantageous form of the present invention;

Fig. 2 is a similar view of a modification thereof;

Fig. 3 is a sectional view, partly in elevation, of another element embodying the present invention;

Fig. 4 is a similar view of still another modification, and

Fig. 5 is a sectional view, partly in elevation of a further modification.

Referring now in detail to the parts of the drawing by reference characters, in Fig. 1 there is shown the heat transfer tube and the arrangement thereof contemplated by the present invention. This form of the invention comprises a fixed, stationary tube sheet 1 and a second fixed tube sheet 2. A straight, thin-walled tube 3, bearing heat-absorbing or radiating fins 4, extends, together with a plurality of similar tubes, between these tube sheets. The fins on this tube may be of the helical type formed by winding on a ribbon of metal edgewise, as shown in the drawings, may be formed by stringing on the tube fins of the washer type, or the tube may have fins of any other type.

At one end of the tube, there is provided means for anchoring this end in a manner which permits the employment of fixed headers in shell-and-tube type gas coolers having finned tubes. These means comprise an outward or radial formation in the tube end, at one extremity thereof, and this formation is here shown as consisting in expanding and flaring the tube end to a flange 13, the flared and flanged end extending at substantially a right angle to the body of the tube. A seat or recess 14 for this flare or flange is formed in the tube hole 15, which up to this point is of a diameter just sufficient to permit the convenient passage of the finned tube, when withdrawn through this end of the heat exchanger. Beyond this point, the tube hole is

enlarged and threaded as shown. Into the threaded, enlarged end of the tube hole extends a clamp or locking member 16 for securing the tube-end in fluid-tight relation to the tube sheet. This locking member may have a plug-like form as shown, consisting of a headed hollow member having its inner end threaded on the outside, and the nut may also have a suitable polygonal grip, or a slot or the like on the outer end to facilitate removal thereof by a wrench or a screw driver or the like. The inner face of this nut is shaped to clamp the margin or rim of the flange 13 against shoulder 15', the inner portion of the nut being countersunk to permit free movement of the annular inner part of flange 13 under expansion and contraction.

The other end of the tube is anchored in the tube-sheet 1 in the customary manner by passing it through a tube-hole and then expanding the portion 13', with the usual expanding tool, into the tube-sheet.

The functioning of this form of the present invention when the apparatus is in operation is as follows: the heated tube expands lengthwise and applies a force to the flange 13, which, being resilient and flexible, and being firmly held in the tube-sheet, gives or bends and accommodates or absorbs the expansion satisfactorily,—due to a kind of a flat-spring action,—without opening the joint, straining the tube, or injuring the tube-sheet. Under contractive forces, the action is of course the same, in the reverse direction.

The present invention thus provides such a structure and arrangement of parts at the expansion-absorbing end of finned tubes of the present type that a resilient flexible lip is provided, and means for securing the rim thereof to the tube-sheet, thus creating and maintaining a remarkable degree of resiliency and flexibility. At the same time the joint with the tube-sheet is fluid tight and a simple arrangement is provided for removing the tube-end from the tube-sheet without damaging either part. The tube, in spite of the fact that it may be completely covered with fins, can be easily removed from the apparatus without damage to the fins, which are made of such a diameter that the tube can easily pass through the tube sheets.

Thus is entirely obviated the necessity for floating headers or bowed tubes, hitherto thought necessary in such apparatus, and yet the structure is simple and relatively inexpensive to make, while its durability and efficiency are noteworthy.

An improved form and arrangement of parts for the other end of the tube 3 shown in Fig. 1 is illustrated in Fig. 2. In this form, the right hand end is anchored in one fixed tube-sheet 1 by a formation of the tube end itself, cooperating with the tube-sheet and other additional members, in such a manner that it can be easily and quickly removed, without damage to the tube end when the tube has to be withdrawn from the heat exchanger for repair or replacement, so that the entire tube may be easily re-inserted for use. This anchorage consists of the tube-sheet 1, bored through to form a tube hole somewhat in the ordinary fashion, and then countersunk or bored out as shown, on the inner face, to form a wide mouth 5. A bevel 6 is also formed approximately half way through the tube hole. The tube end is shaped outwardly as at 7, and then parallel to its axis, as at 8, and tapered inwardly as at 9 to conform to the contour of the bevel 6. The external diameter of the enlargement thus formed in the tube is preferably not greater than the diameter of the fins 4. A sleeve 10 having the outer face of its inner end shouldered and beveled as shown at 11 to conform to the inner contour of the tube end, is inserted in the tube sheet from the inner side, and is provided with a clamping member 12 to engage on its outer threaded end, whereby, when the member 12 is set up, the sleeve 11 firmly clamps the tube end against the tube sheet, forming a fluid-tight joint that is extremely effective. If desired, packing may be placed at 13'' between the member 12 and the tube sheet. The annular flange formation designated as "7" constitutes an expansion or contraction absorbing or accommodating member, due to its extension at right angles to the direction of action of the expansive forces, its resiliency, and its peculiar shape.

When a tube which is anchored in a tube-sheet in the ordinary manner, is removed from the heat exchanger, both ends are damaged for the expanded portions have to be cut or hammered loose from their anchorages with obvious consequences, but by the use of this form of anchorage, the tube is removed unimpaired in its original form through the hole 15, and can be easily re-inserted when ready for use again.

In Fig. 3 there is shown another modification of this invention. When the coefficient of expansion of the tube differs greatly from that of the tube-sheets, it is necessary to make due provision for this high differential. This form of the invention contemplates a modified expansion-accommodating means and also the provision of said means at each end of the finned tubes. The tube end anchored in tube-sheet 1 comprises one or more radial corrugations 17 at the end of the tube 3b, each of these corrugations including a pair of annular rings similar to the formation 7 above referred to.

There is also an expansible portion formed in the other end of the tube for the purpose of aiding in the absorbing or accommodating of the heat-caused stresses on the tubes and tube-sheets. This formation consists prefer-

ably of similar corrugations 17′, shaped and arranged similarly to those at 17, and for the same purposes. However, at this end of the tube, in order to provide for removing the entire finned tube through one tube-sheet without disturbing the other tubes or the anchorage of the tube-sheets, a different formation of the tube end is provided at the end and may consist of a flange such as is shown at 18, so that its end may fit satisfactorily in a suitable seat 19 in the counterbored tube hole 15′ in the tube-sheet 2.

The tube end is held properly on its seat 19 and in the tube-sheet 2 by a clamping member such as the plug shown at 20. This plug has a central channel 21 for the passage of cooling fluid therethrough into the tube, the inlet end being flared as shown; an inner face ontoured to conform to the outer face of the tube end and to clamp the rim thereof; suitable threads, and, if preferred, either a polygonal grip or a face-slot to facilitate its removal, thus having much in common with the plug shown in Fig. 1.

Another embodiment of the inventive idea is shown in Fig. 4 as comprising an anchorage in the tube-sheet 1 similar to the anchorage therein of Fig. 2, and a different anchorage at the other end of the tube which combines the effective features of the anchorages of the Figs. 2 and 3 with some additions. This anchorage comprises a formation made by continuing the tube 3*c* through the tube sheet 2, where it is corrugated as shown at 25, and the extreme end is then flared outwardly as shown at 26. These corrugations comprise a plurality of flexible flange-like members similar to the annular rings 7. The tube hole 27 is of a greater diameter than the outside diameter of the finned tube, and is partially closed by a bushing 28, having a shoulder 29 forming a grip for removal of the bushing. This bushing has a bevelled seat 30, and its interior fits closely around the plain tube, and is flared out around the corrugations. The outer side of the end of the bushing is threaded to receive a clamping member 31 over the flare or flat to secure it to the bushing.

In Fig. 5, there is shown an anchorage in the tube-sheet 2 which differs from that of Fig. 4 in certain particulars. The tube hole 32 is made of such a diameter that the tube 3*d* can easily pass therethrough, fins and all, and is partially closed by a bushing 33, to assist in supporting the tube. The tube 3*d* passes through both the tube-sheet 2 and the bushing 33, and extends beyond the end of the bushing. It is then lapped backwardly upon itself, as shown, and the lapped portion is corrugated, as shown, or folded, or creased. These corrugations are similar to those of Fig. 4 but may be of any size, and may even be of such a size that they increase the outside diameter of the tube to such an extent that it cannot pass through the tube hole 41. The end of the lapped-back tube 3*d* is flared outwardly and back as at 40 and fits onto a seat 31′ in the end of the bushing 33, which is shaped for this purpose. Over this flare fits a clamping member 43, to thus hold the tube in place. The bushing 33 may also have a polygonal or other grip 42, to facilitate its removal.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a heat exchanger, the combination of a pair of spaced tube sheets and a tube extending therebetween, said tube having heat-radiating fins extending outwardly from the exterior surface thereof, and enlargement at one end thereof, and a flexible flange at the opposite end of larger diameter than said fins and said enlargement and substantially perpendicular to the axis of the tube, means for removably securing said enlargement within an aperture in one of said tube sheets, the other of said tube sheets having an aperture slightly larger in diameter than said fins and said enlargement so as to permit the tube to be inserted and withdrawn therethrough, and means associated with said aperture for removably securing the periphery of said fiexible flange to the tube sheet.

2. In a heat exchanger, the combination of a tube having an enlargement at one end thereof terminating in a conical restriction, a tube sheet having an aperture therein for the reception of said enlargement and provided with a conical seat for receiving the exterior surface of said restriction, a member having a tapered head positioned within said enlargement, and means for drawing said member outwardly to clamp said conical restriction against said seat.

In testimony whereof I affix my signature.

STANLEY BROWN.