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GAP-SEALING STRUCTURE, PARTICULARLY FOR PARALLEL-TUBE HEATING SURFACES OF STEAM BOILERS AND OTHER HEAT EXCHANGERS

Filed Dec. 14, 1964 2 Sheets-Sheet 1

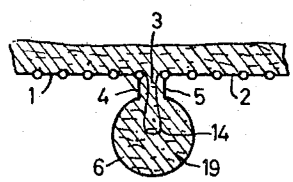

Fig. 1

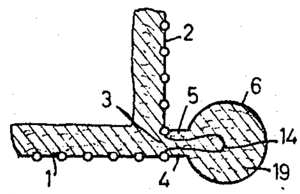

Fig. 2

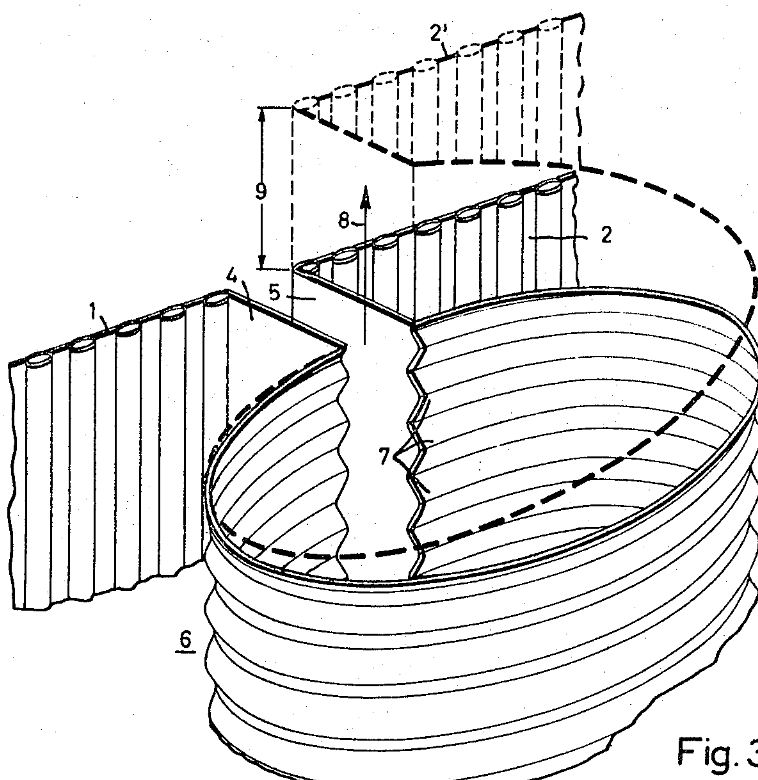

Fig. 3

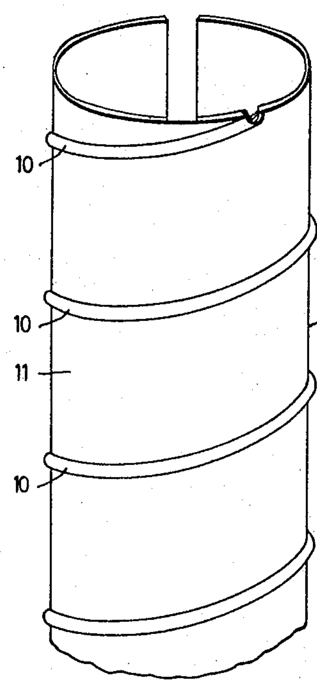

Fig. 4

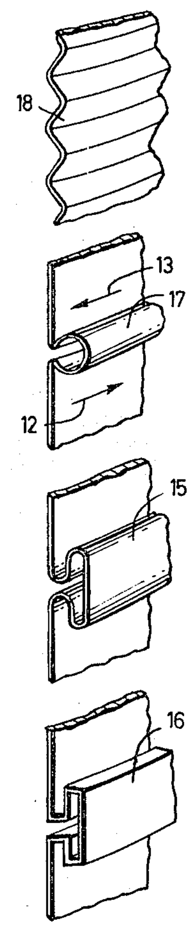

Fig. 5

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GAP-SEALING STRUCTURE, PARTICULARLY FOR PARALLEL-TUBE HEATING SURFACES OF STEAM BOILERS AND OTHER HEAT EXCHANGERS

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My invention relates to bridging structures for sealing gaps between structural components subject to three-dimensional changes in relative positions. In a more particular aspect, the invention concerns gap-sealing structures for large-area parallel-tube walls in steam generators, condensators, heat exchangers and other equipment involving gaps between wall components which, when in operation, are subjected to temperature-responsive deformation, relative displacement or expansion.

In large boiler plants operating with superatmospheric or negative pressure in the firing chamber, there obtains the tendency to depart from the previously conventional masonry construction and to confine the firing chamber and flues by wall structures in which the systems of parallel boiler tubes themselves constitute the wall-forming components. There have become known, for example, welded parallel-tube walls composed of finned pipes or tubes with intermediate spacer strips. To avoid excessive thermal stresses in such structures, the temperature difference between two adjacent finned tubes, welded to each other, must not exceed a given permissible maximum.

It would be desirable if all mutually adjacent tubes always had the same temperature. This, however, is attainable to an appreciable extent only if there exists a relatively large range in which the tubes carry saturated steam or operate under similar steam conditions, this being the case up to about 120 atmospheres (above atmospheric).

Such desirable conditions, however, cannot be realized at operating pressures of 180 atmospheres and more. An approximately equal temperature or a slight permissible temperature difference can be maintained only over a small range in circulatory boilers, for example those having super-heating surfaces in the firing chamber, or between the individual heating-surface components in once-through boilers, even if the above-mentioned finned-tube construction has a most favorable design and operates under most favorable conditions. Consequently, such wall structures must have expansion gaps.

It is an object of my invention to provide for such expansion gaps and to nevertheless secure a good seal along such gaps with reliable means readily applicable in conjunction with parallel-tube wall structures and the various heating surfaces of the above-mentioned kind.

Acording to the invention, the parallel-tube wall structure of a heating surface is subdivided in parallel relation to the direction of the tubes so as to form an intermediate gap, and this gap is covered by a compensator which forms substantially a longitudinally slotted jacket and extends along the gap in bridging relation thereto, the jacket slot registering with the gap, and the jacket edges being in permanent sealing connection with the respective parallel-tube wall portions along the gap. The cross-sectional shape of such a compensator jacket has generally the shape of a C or (capital) omega, and it is further essential to the invention that the compensator jacket is provided with corrugations or folds extending at an angle to the gap and hence transverse to the longitudinal direction of the gap.

The compensator may be directly joined with the wall components, or indirectly through bridges or separate structural elements having a straight edge on one side and having on the other side a shape adapted to that of the compensator jacket. The corrugations or folds of the compensator preferably extend in a direction perpendicular to the longitudinal extent of the gap. The spacing between the individual compensating corrugations need not necessarily be uniform. A group of corrugations, for example three, may be close to each other, and the next following portion of the jacket may be free of corrugations along a length greater than the total axial length of the group of corrugations. For reducing shearing stresses, it is in some cases advisable to have the corrugations or folds extend in an inclined direction so as to form an angle to the axis of the compensator.

To prevent local peaks in tension and to have any stresses, particularly shearing forces, acting upon the compensator, as uniformly distributed as feasible, any straight or sharp bends in the compensator should be avoided. Furthermore, the corrugations or folds, especially if a rather large relative expansion is to be expected, may be given such a design that the gliding angle is uniform and as small as possible at all localities. This, for example, is the case when using large compensating folds and distributing them uniformly, employing for example a meander-shaped cross section of the folds.

As mentioned, the compensator has substantially the shape of a slotted jacket. When the wall structure forms a heating surface of a firing chamber, the slot may pose the danger that dust will enter into compensating folds. To prevent this, the slot of the compensator may be closed by overlapping and mutually sliding portions of the compensator structure. In the case of long compensators, it may also be advisable to subdivide the inner space of the corrugations or folds by partitions to prevent the occurrence of smoke-gas flow within the compensator. Filling the interior of the compensator by ash, soot or other deposits can also be prevented by suitable other expedients, for example adding a foil or an asbestos web. However, if desired, ash outlets may also be provided in spaced relation from each other.

The invention will be further described with reference to embodiments illustrated by way of example on the accompanying drawings.

FIGS. 1 and 2 show schematically respective sectional views of a firing-chamber wall composed of parallel-tube heating surfaces with an intermediate gap sealed by a bridging structure according to the invention.

FIG. 3 shows schematically and in perspective section a portion of a bridging structure.

FIG. 4 is a schematic and perspective view of a different bridging structure; and

FIG. 5 shows four different cross-sectional shapes of the corrugations or folds with which a bridging structure according to the invention may be equipped.

According to FIGS. 1 and 2, two parallel-tube panels 1 and 2 form adjacent portions of a firing-chamber wall and are separated by an expansion gap 3. The individual tubes are designed, for example, as fin-type tubes, each having two longitudinal fin strips diametrically opposite each other, with each fin welded to the adjacent fin of the next tube. However, the panels may also be formed of smooth pipes which are welded together with spacer strips to form a closed parallel-tube wall. Bridge strips 4 and 5 are welded to the wall components 1 and 2 at the side facing away from the firing chamber. A compensator jacket 6 is welded to the bridge strips 4 and 5. FIG. 1 relates to a sealing bridge structure for a gap between two register walls in the same plane, whereas FIG. 2 shows a corresponding corner seal at the outer side of a rectangular firing chamber.

Details of a suitable compensator design will be described with reference to FIG. 3. The above-mentioned bridge strip 4 is welded to the outermost tube of the wall component 1 formed by the welded fin tubes. The other bridge strip 5 is welded to the corresponding outer tube of the second wall component 2. The compensator 6 has generally the shape of a cylindrical jacket which is slotted parallel to a generatrix of the cylinder, the slot registering with the gap to be sealed. As mentioned, the shape of the compensator jacket may also depart from that of a cylinder, especially if the bridge strips 4 and 5 are omitted and the compensator 6 is to be directly welded to the wall components 1 and 2. It is preferable to employ a cross-sectional shape similar to that of an omega, regardless of whether the shape is inherent in the cross section of the jacket itself, or is formed by the jacket in conjunction with the above-mentioned bridge strips 4 and 5.

It is essential that the compensator jacket 6 does not consist of a smooth cylindrical or similarly shaped structure but, for providing the desired yieldability, is provided with transverse compensating corrugations or folds. Thus, as shown, the entire cylindrical jacket may have a wavy shape as represented in FIG. 3 by a number of parallel corrugations 7 similar to those separately shown at 18 in FIG. 5.

The design, arrangement and number of the compensating corrugations or folds depends upon in which directions and to which extent the parallel-tube walls are expected to become deformed and hence which amount of deformation is to be absorbed by the compensator. As a rule, during operation of a heating surface according to FIG. 1 or FIG. 2, there occur decreases and increases in width of the gap 3 between the wall components 1 and 2. The resulting heat-responsive motion can be readily followed by a compensator without any corrugations. However, there are also heat-responsive movements of the wall components in the direction of the arrow 8 or in the opposed direction, such movements occurring with or without appreciable transverse displacements of the first-mentioned kind. A smooth compensator would withstand any resulting longitudinal deformation only to a very limited extent, whereas a compensator according to the invention is largely free of such limitation.

In practice, for example, the individual tubes of the wall components 1 and 2 according to FIG. 3 may have a diameter of 38 mm. and may be welded together at a distance of about 60 mm. from each other. The compensator 6 for this purpose has diameter of about 400 mm. At a boiler height of about 30 m., such a compensator affords coping with a relative elongation 9 of up to 60 mm. With such an elongation, the tube wall 2 assumes relative to wall 1 the position shown by broken lines at 2'.

In the embodiment shown in FIG. 4, the compensating corrugations or folds 10 do not extend perpendicularly to the axis of the compensator jacket but at an angle thereto. That is, the compensating corrugations have the illustrated inclined or helical position prior to occurrence of any relative elongation. One or more compensating corrugations 10 are helically arranged and are spaced from each other by relatively long cylindrical, uncorrugated jacket portions 11.

FIG. 5 illustrates sectional portions of the compensator jacket with respectively different corrugations or folds. The fold 17 has a cross-sectional shape resembling a C or an omega, being in this respect similar to the cross-sectional shape of the jacket. In the event of relative elongation between the tube walls 1 and 2, there occur relative displacements at the compensator in the direction of the arrows 12 and 13 or in the opposed directions.

Shown at 15 and 16 in FIG. 5 are other cross-sectional shapes of the applicable folds. These are preferable, for example, for the purpose of changing the effect of shear stresses or for more conveniently accommodating the bridging structure within the heat insulation of the wall. As shown in FIGS. 1 and 2, the bridging structure is further provided with foils 14 for preventing the ingress of ash or other deposits into the compensator. If desired, the interior of the compensator 6 or of the folds 7 may be provided with a filling 19 of asbestos in pulverulent or fibrous form.

Accumulation of ash, soot and other deposits can also be counteracted by giving the compensating folds a rather flat, wavy configuration. From this viewpoint, it is advisable to avoid the formation of pockets and to employ a wavy profile as shown at 18 in FIG. 5 having a rather slight curvature at the wave peaks, and valleys, so that an accumulation of dust is largely prevented.

The profile of the corrugations may also be chosen so as to obtain as uniform a distribution of stresses as possible and to largely prevent the occurrence of local peaks in mechanical tension. For this reason, it is advisable to avoid as much as possible any sharp bends or knees in a single plane. On the other hand, a wave-shape profile in a plane, is not objectionable. Furthermore, the cross section of the corrugation is preferably made large enough to obtain small gliding angles and thereby a corresponding reduction in shearing forces. The shape of the corrugations shown at 18 in FIG. 5 satisfactorily meets all of the above-mentioned requirements.

To those skilled in the art, it will be obvious upon a study of this disclosure, that my invention permits of various modifications and may be given embodiments other than particularly illustrated and described herein, without departing from the essential features of my invention, and within the scope of the claims annexed hereto.

I claim:

1. A bridging structure for sealing gaps between parallel-tube walls of steam boilers, heat exchangers and the like, comprising two adjacent component walls each having parallel tubes for working fluid, said two components forming between each other a longitudinal gap parallel to said tubes, a compensator forming a longitudinally slotted jacket of generally C-shaped cross section and extending along said gap in bridging relation thereto with the jacket slot in registry with said gap and the jacket edges in permanent sealing connection with said respective members along said gap, said compensator jacket having compensating corrugations transverse to longitudinal direction of said gap.

2. In a bridging structure according to claim 1, said cross section of said compensator having the shape of a capital omega.

3. In a bridging structure according to claim 1, said compensator jacket comprising corrugation-free portions intermediate said corrugations.

4. In a bridging structure according to claim 1, said corrugations extending helically about the axis of said compensator jacket.

5. In a bridging structure according to claim 1, said corrugations having individually a folded shape in form of an inwardly slotted jacket.

6. In a bridging structure according to claim 1, said corrugations having a wave-shaped cross section with rounded crests and valleys to minimize dust accumulation.

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