May 20, 1969 J. COOPER ET AL 3,444,841

VAPOR GENERATOR SEAL ARRANGEMENT

Filed Oct. 11, 1967 Sheet 1 of 2

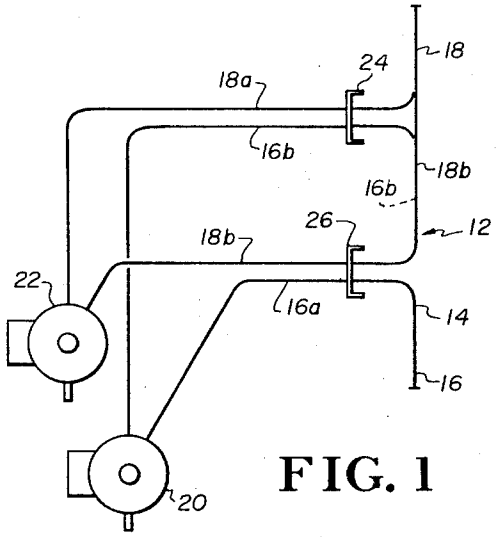

FIG. 1

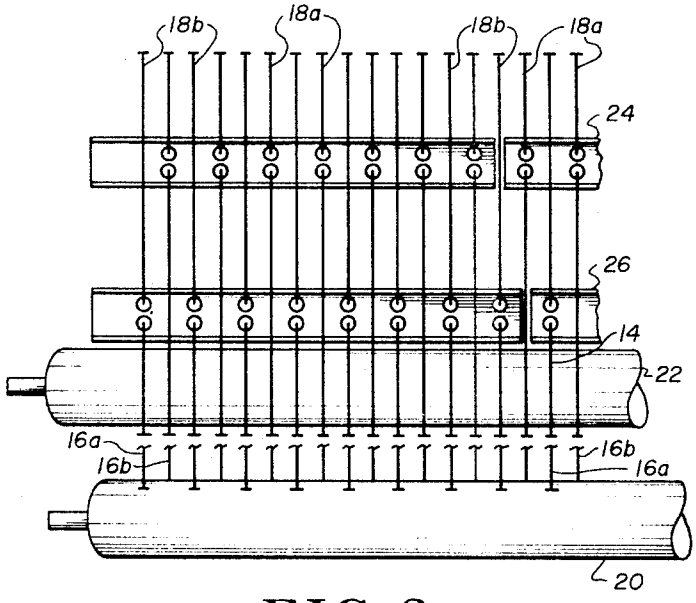

FIG. 2

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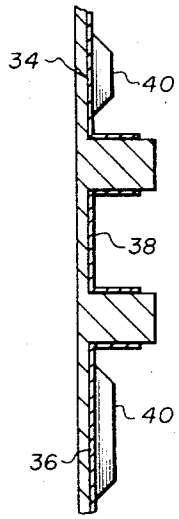

FIG. 3

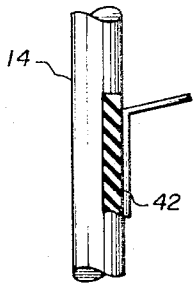

FIG. 4

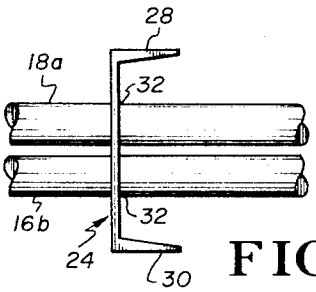

FIG. 5

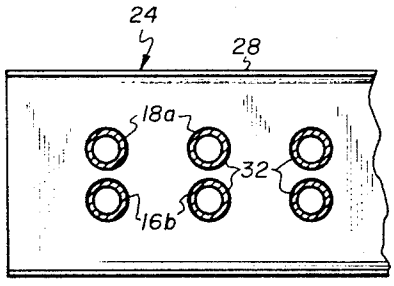

FIG. 5A

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VAPOR GENERATOR SEAL ARRANGEMENT

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U.S. Cl. 122—6 6 Claims

ABSTRACT OF THE DISCLOSURE

A seal arrangement for a pressurized wall of a vapor generator in which tubes penetrating the wall or entering the wall at an angle thereto pass through and are seal welded to a tube sheet or channel spaced from the wall, and seal plates extend between the channel and wall.

The present invention relates to improvements in sealing the wall of a pressurized vapor generator, and in particular, to an arrangement for sealing a wall in the area in which tubes penetrate or enter the wall at an angle thereto.

An example where the present invention is useful is in the case where the generator furnace section is divided into upper and lower portions, the upper portion being top supported. Alternate tubes of the upper and lower portions extend through a common plane so that parts of these tubes are coextensive and interlaced with each other. The coextensive and interlaced parts are welded together so that the lower portion of the furnace is supported by the upper portion. Above and below this common plane, the tubes are bent outwardly of the furnace area and are connected to suitably arranged headers.

Although the vapor generator wall is welded above and below the area in which the tubes are bent outwardly from the plane of the wall, and in the common plane itself, by longitudinal seal welds, intertube spaces or openings must occur at the points where one tube will take a diverging path from an adjacent tube.

It has been proposed to weld small plates in these intertube spaces or openings, but because of expansion in the wall on heating, excessive stresses are created by these seal plates frequently resulting in cracking of the plates or tubes.

It is an object of the present invention to provide an improved sealing arrangement for a vapor generator wall which is substantially all welded and wherein tubes penetrate or enter the wall at an angle thereto.

In essence, the present invention comprises a plurality of parallel closely spaced water cooled tubes defining a planar surface, the tubes having their intertube spaces closed in most part by metallic webs. A second group of tubes penetrates or enters the surface from a point outside of the surface and at an angle thereto. Seal means for the penetration comprises a channel means disposed outside of the surface through which the penetrating tubes extend. The penetrating tubes are seal welded to the channel means, and seal plates are seal welded to and between the channel means and the planar surface.

The invention and advantages thereof will become more apparent upon consideration of the following specification, with reference to the accompanying drawings in which

FIGURE 1 is a section view of a wall of the generator showing the arrangement of tubes and the manner in which the generator wall is penetrated;

FIGURE 2 is an elevation view of the wall of FIG. 1;

FIGURE 3 is a detail view of the wall of FIG. 1 showing the manner in which the wall is sealed in accordance with the invention;

FIGURE 4 is a detail view showing connection of the seal plates with the wall;

FIGURE 5 is a detail section view of a channel in accordance with the invention; and

FIGURE 5A is an elevation view of the channel and tube arrangement of FIG. 5.

Referring to the drawings, there is illustrated a vapor generator wall **12** which is part of the furnace section of the generator, comprising vertically oriented water cooled tubes **14**. Details of the generator wall are described in copending application Serial No. 613,632, filed February 2, 1967, by Walter P. Gorzegno, Frederick H. Weber, and Robert H. Pai, entitled "Multiple Pass Design for Once-Through Steam Generators." Application Serial No. 613,632 was in turn a division of United States application Serial No. 370,604, filed May 27, 1964, by the above-mentioned inventors, now United States Patent No. 3,324,837.

In essence the above-mentioned copending application and patent relate to a once-through vapor generator which utilizes the "Benson" principle, wherein heated riser tube circuits are coupled to unheated downcomer circuits for the furnace enclosure wall. Until recently, the Benson principle was associated with a skin cased construction, in which the tubes or tube panels lining the combustion chamber were encased by a metal casing and insulation, providing a gas-tight construction. A more recent advance was the development of the all-welded membrane wall, wherein the parallel tubes of the combustion chamber were seam or seal welded together, providing a gas-tight construction and replacing the casing and insulation of prior units. However, the all-welded membrane wall construction created serious stress and sealing problems in instances where the wall was penetrated by tubes passing either through the wall or into the wall, at an angle thereto.

Such instances may arise when superheater tubes pass through the membrane wall, or more often in the connection of flow passes of the furnace section. In the above-mentioned copending application, and the above-mentioned patent, a furnace circuitry was described in which a plurality of flow passes in series relationship with each other define the generator furnace. At least one of the passes occupies the upper portion of the furnace enclosure, and the other passes occupy the lower portion of the furnace enclosure. The furnace enclosure is top supported by suitable frame work or structure outside of the generator. Headers for the upper and lower portion passes are disposed outside of the furnace periphery in the area of the junction between the upper and lower portions, and the tubes of the upper and lower portion passes are bent outwardly from the plane of the enclosure to connect to the headers.

Referring more particularly to the figures, the tubes of the lower portion of the furnace are designated with the numeral **16** and the tubes of the upper portion are designated with the numeral **18**. As shown in FIG. 1, some of the tubes **16**, designated **16***a*, preferably alternate tubes, are bent outwardly along a first lower plane to header **20** for these tubes. The remaining tubes of the lower pass, **16***b*, extend on upwardly to a second plane, where they are bent outwardly from the furnace wall and extend to header **20**.

The upper tubes **18** as with the lower tubes **16** diverge in the area of the upper plane, a first group, **18***a*, being bent outwardly along this plane and extending to header **22**, the remaining tubes **18***b* passing on downwardly so that they are coextensive with and interlaced with the tubes **16***b* in a common plane intermediate the panels of the tubes **16** and **18**. As shown, the tubes **18***b* are bent outwardly along the lower plane to the header **22**.

Whereas the tubes **16** and **18** are welded together to form a gas-tight panel above and below the areas where they extend or are bent outwardly from the generator wall, and whereas the interlaced tubes **16** and **18** in the common plane intermediate the areas where the tubes diverge from the wall are also welded together (for the purposes of support of the lower wall by the upper wall), it is apparent that intertube spaces or openings will exist at the points of divergence of the tubes from the generator wall.

It is an object of this invention to seal the intertube spaces.

FIGS. 1 and 2 show upper and lower channels **24** and **26** having openings therein through which the horizontally extending tube portions (**16***a* and *b* and **18***a* and *b*) extend. FIGS. 5 and 5A show details of the channel and penetration of the channel by the tubes in greater detail. In essence the channel is U-shaped provided with upper and lower flanges **28** and **30**. Apertures **32** accommodate the tubes (**16***b* and **18***a*, FIG. 5) which tubes are welded peripherally to the channel sealing the clearance between the tubes and channel.

Referring to FIG. 3, L-shaped upper and lower seal plates **34** and **36** are seal welded between the channel flanges and the generator wall. An intermediate U-shaped seal plate **38** is welded between the flanges of the upper and lower channel members approximately coextensive with the common plane of the tubes of the upper and lower passes. Expansion folds of conventional design (item **40**) may be disposed in the seal plates to permit the plates to expand and contract horizontally with expansion and contraction of the furnace.

FIG. 4 illustrates an arrangement in which the seal plates can be welded to the generator wall. The wall, comprising tubes **14** is provided with a scalloped bar which conforms to the tube configuration and surface of the wall, extending a short distance from the wall. The seal plates are provided with an angled flange which is welded to the scalloped bar.

This has the advantage that it provides a flat surface which can be readily engaged by and welded to a flat edge of a seal plate flange. Similarly, the flanges on the channel members provide surfaces which can be welded to and engaged by the seal plates without the requirement of close tolerance work. In this respect, it would be possible to use a rigid tube sheet in place of the channel member, but the channel member has the advantage in that it provides flanges or working surfaces.

Insulation **42** disposed between the tube wall and the channel and seal plates keeps the latter cool and permits the use of a low alloy carbon steel. In the absence of insulation, an alloy rolled plate material suitable for high temperature use would have to be employed.

It is an aspect of the invention that a portion of the joint assembly, namely the arrangement shown in FIG. 1, would be shop assemblied and shipped to the field. Such welds as those between the tubes and headers, and between the channels and tubes, require the skill and close tolerance work that can only be achieved in the shop. On placement in the field, and connection of the tube ends, the insulation **42** can then be applied, and the seal plates can be welded between the channels and generator wall surfaces. These latter welds can be effected in the field as, by virtue of the use of flanges, the work is less critical.

An alternative to the scalloped bar arrangement described above is that which may be found in U.S. Patent No. 3,303,876, Berman et al. In this patent, there is described a shaped bar or tapered bent plate which is suitable for stress free transition from a fin centered between the tubes, in the plane of the centerlines thereof, to a fin which defines a relatively flat sealing surface between and with the tubes. The sealing plates of the present invention can then be welded directly to the relatively flat area defined by the tapered bent plate and tubes.

Although the invention has been described with reference to specific embodiments, variations within the scope of the following claims will be apparent to those skilled in the art.

What is claimed is:

1. A vapor generator comprising,

a plurality of vertically aligned parallel closely spaced water cooled tubes defining an upright planar surface having inner and outer sides, the tubes having their intertube spaces closed in most part by metallic webs;

at least one additional group of tubes horizontally arranged penetrating said surface from a point outside of said surface at an angle thereto;

seal means for said penetration comprising horizontally aligned channel means having openings therein through which said additional group of tubes extend, said channel means being spaced from the planar surface;

said additional group of tubes being seal welded to the channel means;

the channel means including upper and lower flanges;

horizontally extending bars on the planar surface seal welded to the outside thereof above and below the channel means and coextensive therewith;

upper and lower plate means seal welded to and between the channel flanges and the horizontally extending bars;

refractory insulation between the channel and plate means and the planar surface around said additional group of tubes to protect the channel and plate means from radiation.

2. A vapor generator comprising

a plurality of vertically aligned parallel closely spaced water cooled tubes defining an upright lower planar surface;

a second group of vertically aligned closely spaced water cooled tubes defining an upright upper planar surface above but contiguous and aligned with said lower planar surface;

said tubes having their intertube spaces closed in most part by metallic webs;

means top supporting said upper planar surface;

alternate tubes of both said planar surfaces extending through a common plane between the surfaces so that portions of tubes of each of said surfaces are in coextensive and interlaced relationship, intermediate tubes of both said surfaces being bent outwardly of said surfaces above and below said common plane, the interlaced tubes also being bent outwardly above and below said common plane to define upper and lower groups of angled tubes extending at an angle to said planar surfaces;

the interlaced tubes being welded together for support of the lower planar surface by the upper surface;

seal means for said generator in the area of said common plane comprising upper and lower channel means spaced from the planar surfaces and including openings therein through which said upper and lower groups of tubes angled relative the planar surfaces extend;

seal welds between said channel means and the groups of angled tubes;

upper and lower flanges on each of said channel means; and

upper and lower plate means seal welded to and between each of the channel flanges and the planar surfaces.

3. A generator according to claim **2** further including refractory insulation between said channel and plate means and the planar surfaces to protect the channel and plate means from radiation.

4. A generator according to claim **2** including upper and lower bars above the uppermost channel and below the lowermost channel seal welded to said planar surfaces, the plate means being welded to said bars.

5. A generator according to claim 4 wherein a single plate of U-shape cross section is welded to and between the upper and lower channel means approximately coextensive with the common plane sealing the generator in this area.

6. A forced circulation fluid heating unit comprising

upright walls forming a furnace for the flow of heating gases, the furnace having a predetermined periphery;

means supplying high temperature gases to said furnace;

at least one of said walls including a first group of upwardly extending fluid heating tubes arranged in spaced relation and for parallel flow of fluid therethrough and having their intertube spaces closed in most parts by metallic webs to form a lower portion of said one wall;

a second group of upwardly extending fluid heating tubes arranged in spaced relation and for parallel flow of fluid therethrough and having their intertube spaces closed in most part by metallic webs to form an upper portion of said one wall;

a predetermined number of the tubes of the second group having lower portions interlaced and coextensive with upper portions of a predetermined number of the tubes of the first group;

means for supporting said one wall including web means rigidly uniting said interlaced tube portions of the first and second group of tubes and transmitting the load of the first group of tubes to the second group of tubes;

means for top supporting the second group of tubes;

the remaining tubes of the first and second groups being bent outwardly above and below the area in which the groups are coextensive, the number so bent outwardly being sufficient so that the interlaced portions fit into the periphery of the furnace;

the interlaced tubes also being bent outwardly along with said remaining tubes above and below said area in which the groups are coextensive after passing through said area;

seal means for said wall comprising channel means through which said outwardly bent tubes extend;

plate means seal welded to and between flanges of said channel means and said upright walls;

means sealing said outwardly bent tubes with said channel means.

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U.S. Cl. X.R.

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