Jan. 2, 1951 J. P. CRAVEN 2,536,039

FLUID HEAT EXCHANGE INSTALLATION
AND METHOD OF FORMING THE SAME
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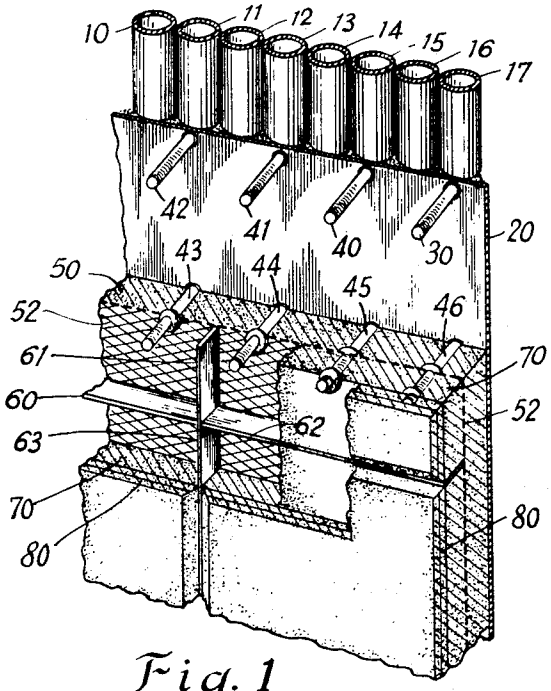


Fig. 1

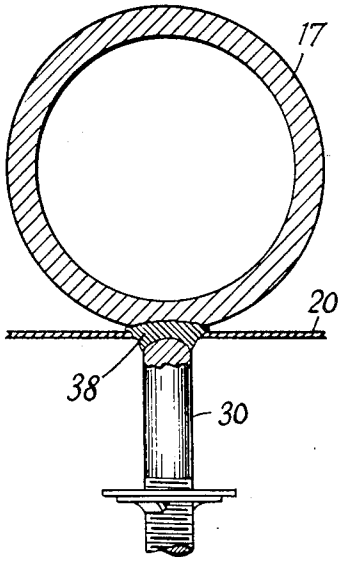


Fig. 2

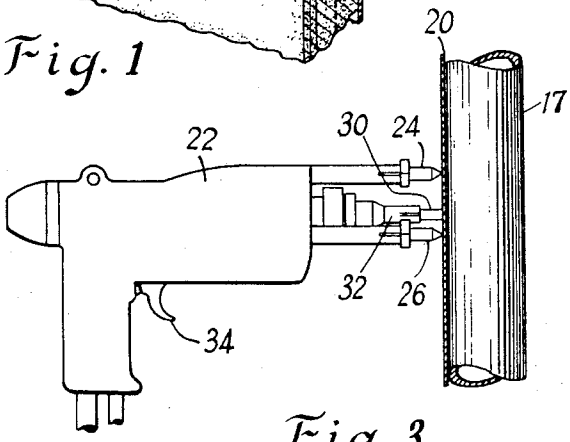


Fig. 3

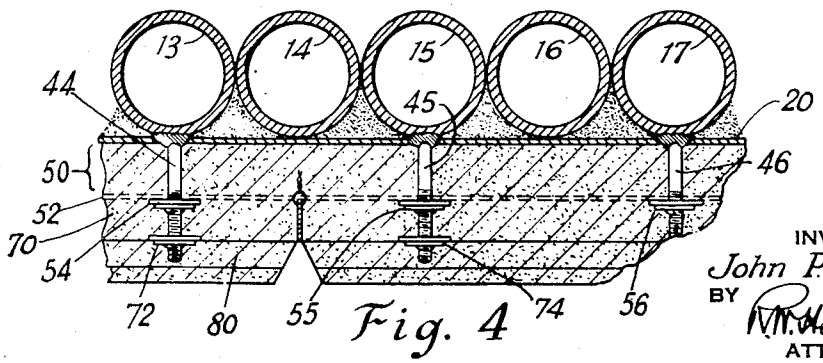


Fig. 4

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FLUID HEAT EXCHANGE INSTALLATION AND METHOD OF FORMING THE SAME

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11 Claims. (Cl. 122—6)

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This invention relates to heat exchange installations, and it is particularly adapted for advantageous use in installations in which high temperature furnace gases are utilized to generate a gas or vapor in fluid carrying tubes connected into a circulation system. The invention involves a novel construction method and a novel furnace wall as the product of that method.

The invention is particularly adapted for use in the erection of the waterwall furnaces of water-tube steam generators in which upright water tubes serve as supports for the furnace wall. In the illustrative wall, steel sheets of large area are disposed tangentially across successive tubes and are welded thereto, gas or air leakage being substantially eliminated by seal welds joining adjacent sheets along their edges.

The combination, including a casing formed by such light weight metallic sheets welded to the exterior of the tubes and in thermal contact therewith so that it attains the temperature of the contacted tube metal, is particularly advantageous for high temperature fuel burning furnaces and related heat exchange apparatus where the gases are under superatmospheric pressure and where a draft tight wall is necessary. The use of comparatively thin sheets keeps the overall weight down and avoids the transmission of stresses to the tubes due to temperature changes in the casing.

Thermal insulation, to minimize the heat loss from the exterior, may be applied as a plastic to the exterior surfaces of these sheets, and, to anchor this insulation, metallic studs are welded to the tubes through the sheets at distributed positions over the areas of the sheets and sealed with the sheets in unitary operations. These positions are preferably directly opposite the tangency positions of the sheets and the tubes, and the welding is so conducted that each weld also involves the inter-fusion of the tube metal and the sheet metal. Thus, each stud is rigidly secured to a tube, and the interposed metallic sheet or casing section is secured to both the tube and the stud by the same operation. Reticulated metal may be secured to the studs and spaced outwardly of the casing sheets to anchor the thermal insulation when the latter is installed as a plastic. In this case the reticulated metal may be embedded in the insulation.

In the illustrative erection method, the studs may be quickly applied over the areas of the casing sections by procedure involving the use of a flash resistance welding device, the interposed casing sections protecting the tube metal against

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overheating during the welding process. This method also facilitates the use of a relatively thin sheet metal to form a draft tight casing by eliminating the difficult job of aligning openings in the casing with studs previously applied directly to the tubes.

The illustrative heat exchange installation, and the illustrative method of construction, involve a marked reduction in fabrication costs due to the single weld attachment of each stud through the imperforate metal of the sheets as compared to the previous practice of perforating the sheets and aligning the perforations with studs previously secured to the wall tubes. Costs are further reduced by the utilization of flash resistance welding in welding the studs separately to the tubes through the casing sheets. The material and labor costs are much less than in other practices involving perforations of the sheets of the manual arc welding and the sheets by forming plug type welds in the sheet perforations.

Another advantage of the illustrative installation and the illustrative method resides in the structural arrangement whereby the load of the exterior thermal insulation as transmitted to the studs is carried directly to the tubes which form the structural support members for the wall, and only one weld intervenes between the load receiving portion of the stud and the tube.

The invention will be described by reference to the accompanying drawings, and other objects of the invention will appear as the description proceeds.

In the drawings:

Fig. 1 is a fragmentary view of the illustrative furnace wall construction, cut away at different positions for clarity of disclosure;

Fig. 2 is a view in the nature of a horizontal section, particularly showing the relationship of the casing, a stud, and a vapor generating tube;

Fig. 3 is a diagrammatic view in the nature of a side elevation illustrating the manner of simultaneously welding the studs and the casing to the tubes; and

Fig. 4 is a horizontal section through the illustrative furnace wall.

The wall construction disclosed in the drawings is provided for use in the erection of such steam generating installations as that shown in the patent to Bailey, 2,357,300. The upright steam generating wall tubes act as supports for the wall, and the illustrative wall construction is applicable to steam generating installations in which the furnace wall tubes are spaced apart along the wall, as well as to those constructions

in which the wall tubes are substantially in contact, as illustrated in Figs. 1 and 3 of the present drawings. When the wall tubes are spaced apart, they may have metallic studs radially secured thereto, and a highly refractory chrome ore composition may be installed as a semi-plastic around the studs and over the surfaces of the tubes. In the embodiment indicated in the drawings, such a highly refractory material is installed as a plastic between the wall tubes 10–17, inclusive, and the sheet metal casing section 20.

In the erection of the illustrative wall, the vapor generating tubes are secured in their operative relationships to other pressure parts of the installation, such as the upper and lower headers, steam and water drums, etc. Metallic casing sections are then disposed along the row of tubes in tangential relationship to their outer surface. Then studs are secured by welding them to the tubes through the metal of the casing sections. This is accomplished by forcing a stud member through the thin metallic sheet which is fused by the flow of electric current therethrough, the metal at the tube end of each stud and some of the tube metal being simultaneously fused. In this manner a good strength weld is attained between the stud and the tube, and this weld also forms a seal weld between the periphery of the stud projection and the surrounding portion of the casing metal. The softening of the metal of the tube end of the stud, the adjacent sheet portion, and a part of the tube wall, and the pressure applied during the welding results in an upsetting so that the area of contact for strength and for heat transfer between the sheet and the tube is appreciably greater than the original diameter of the stud.

This securement of the studs may be attained by using a stud welding device of a type such as that shown by the patent to Anderson—2,360,837, October 24, 1944, or by either of the types shown by the Nelson Reissue Patent 22,314, May 11, 1943 or the Trainer et al. patent—2,003,320, June 4, 1935. The illustrated welding device 22 has three adjustable feet such as those shown at 24 and 26 in the drawings. These feet are preferably equally circumferentially spaced and are adjusted so as to determine the correct position of a stud 30 when it is gripped in the chuck 32. The feet 24 and 26 are pressed against the casing section 20 and the equipment is so adjusted and held that the stud is directly over the position of tangency between the casing section 20 and the tube 17.

The welding operation effected by the resistance welding device 22 is then initiated by pulling the trigger 34, it being understood that the tube and the stud in the chuck of the welding device are the electrodes of the welding electric circuit. In the operation of the device, the stud is withdrawn slightly from the casing section 20 to produce a metal fusing arc, and as soon as the effect of the arc has resulted in relatively superficial fusion of the tube metal at the point of tube and casing tangency, the stud 30 is fused and pressed into the fused metal of the casing section and the tube to form such a fusion zone as that indicated at 38 in Fig. 2.

The entire operation of uniting a stud and casing section and a tube takes but a few seconds so that a large number of the studs may be applied over the areas of wide casing sections in a relatively short time.

After the studs such as 30 and 40–46, inclusive, are applied in such an arrangement as that indicated in Fig. 1, a stratum 50 of thermal insulation is applied to the exterior surface of the casing section. This stratum is held in position by sheets of reticulated metal such as that shown at 52. The studs project through the openings in the reticulated metal as indicated in Figs. 1 and 4, and the metal is secured in its operative position by fasteners such as 54, 55, and 56 which may be screw-threaded on to the studs.

Thereafter, joint screeds 60—63, preferably of non-combustible material, are secured to the reticulated metal 52 so as to designate wall areas or pockets in which the stratum 70 of thermal insulation may be applied as a plastic. The screeds are also utilized in the insulation of this installation to obtain the desired thickness and surface of the insulation material. Thereafter, other fastening devices such as 72 and 74 (Fig. 4) are applied to hold the stratum 70 in operative relationship. These fastening devices, the ends of the studs, and the exterior surface of the installation stratum 70 may be then covered by a hard finish material 80 installed as a plastic. This material is preferably one which will not only protect the exterior surface of the wall against mechanical damage, but which will also promote the thermal insulation properties of the wall.

By tightly fitting adjacent casing sections such as the section 20 over the entire wall areas of the installation a draft-tight casing is provided at a minimum expense, and the erection time for such installations is materially reduced. The use of the invention eliminates such operations as the perforation of the casing sections to receive studs which have previously been welded to the tubes, and in this connection, considerable erection time is saved because there is no necessity for aligning the previously applied studs and perforations in the casing sections, when the latter are applied.

By the interposition of the casing section 20 between a tube and a stud, the casing section acts as a shield to protect the tube against excessive fusion of tube metal, although, of course, the metal fusion is limited by the character of the electric arc and the time of its application. These factors are determined in advance for studs, tubes, and casing sections of different materials and different thicknesses.

When the metallic sheets for the casing sections are of carbon steel and the tubes and headers associated therewith are of the same material, the heat transfer between the casing sheets and the outer tube wall will be such that these components operate at substantially the same temperatures, thus eliminating the setting up of damaging temperature stresses between them. Conditions such as furnace temperatures or gas temperatures affecting the interior surface of the wall, or the spacing of the wall tubes may be such as to cause the average temperature of the casing sheets to differ materially from that of the pressure parts, and in such cases the invention contemplates the use of sheets of such a metal or alloy that they will have a coefficient of expansion which is greater than that of the pressure parts. Chrome nickel alloys or aluminum and some of its alloys have such coefficients of expansion. When the casing sheets are disposed at a greater distance from the plane of the tube axes, and particularly when the tubes are spaced apart so that more heat is trans-

mitted between the intertube spaces, a change in the average temperature of the casing is effected. In this instance, although the stud would pierce the metal of the tube sheet and be welded to the tube for a strength weld, the sheet would not be tangent to the tubes.

It is to be understood that the terms such as "sheet metal," "thin metallic sheets," and "flat metal casing sections" or similar terms, used herein are intended to cover metal members sometimes referred to in the art as sheets, and sometimes referred to as plates.

I claim:

1. In a tubular heat exchanger, a row of spaced wall tubes normally subject externally to a heat exchange medium, and closure means for the spaces between the tubes disposed externally of the plane of the tube axes, said closure means including imperforate thin metallic sheets extending transversely over a plurality of tubes and longitudinally thereof in spaced relationship with the plane of the tube axes, metallic studs extending substantially outwardly from the rear faces of the tubes which are covered by the sheets, said studs being secured in pressure tight union with the sheets and the tubes by unitary welds.

2. In a fluid heating installation, fluid heating tubes having their outer surfaces exposed to high temperature gases, a draft-tight metallic casing including sections of sheet metal extending tangentially across successive tubes, insulation anchoring studs welded to said sections and extending outwardly therefrom at positions substantially registering with the points of tube and section tangency, each stud being secured by a single weld which unites a tube and a casing section as well as the stud and the tube, and thermal insulation covering the exterior sides of the sections and anchored thereon by the studs.

3. In the erection of a tubular heat exchanger, erecting a row of wall tubes connected into their operative relationship with other circulatory parts of the exchanger, applying sheet metal casing sections across successive tubes and tangentially thereof, and welding the sections to the tubes by welding insulation anchoring studs to exterior surfaces of the sections at positions registering with the points of tangency of the sections to the tubes, the unitary weld at the inner end of each stud extending axially of the stud and including some of the tube metal.

4. In the art of constructing steam generator installations, disposing steam generating wall tubes in operative relationship to other pressure parts, juxtaposing imperforate metallic casing sections across and in tangential relationship to successive tubes, securing said casing sections to the tubes by welding insulation attachment anchors to the exterior faces of the sections at positions in radial alignment with the positions of tangency contact between the tubes and said sections, and then applying thermal insulation about said anchors and over the exterior faces of said sections.

5. In the erection of tubular heat exchangers, erecting a row of wall tubes, positioning sheet metal casing sections tangentially across the erected tubes, and welding the sections to the tubes by welding insulation anchoring studs to exterior surfaces of the sections at positions substantially registering with the points of tangency of the sections to the tubes.

6. In a fluid heating installation, fluid heating tubes normally exposed to high temperature gases, draft tight sheet metal casing sections

extending tangentially across a plurality of successive tubes, insulation anchoring studs secured to said sections and extending outwardly therefrom at positions substantially registering with the positions of tube and section tangency, a unitary weld at the inner end of each stud extending axially of the stud and including some of the metal of a casing section and a tube, and a thermal insulation stratum covering the exterior sides of the sections and anchored thereon by the studs, the studs extending outwardly through said stratum.

7. In the art of steam generation, erecting steam generating tubes in their operative relationships with other components of a steam generator, disposing sheet metal casing sections across the tubes with their interior surfaces in tangential relation to the tubes, and welding insulation anchoring studs endwise to the exterior surfaces of the casing sections at positions in radial alignment with the positions of tube and casing section contact, the fusion of said welding also extending through the sections and into the tube metal at said positions.

8. In the erection of tubular heat exchangers, erecting a row of wall tubes in operative relationship to other circulatory parts of the exchanger, juxtaposing sheet metal casing sections tangentially across said tubes and exteriorly thereof, and welding said sections to the erected tubes by end welding insulation anchoring studs to the exterior surfaces of the sections at positions substantially registering with the points of tangency of the sections to the tubes.

9. In a fluid heat exchange installation, fluid heating tubes disposed in row arrangement and having their outer surfaces exposed to high temperature gases, draft-tight sheet metal casing sections disposed tangentially across successive tubes, insulation anchoring studs secured to said sections and extending outwardly therefrom at points substantially registering with the positions of tube and section tangency, a single unitary weld at the inner end of each stud extending axially of the stud and including metal of a casing section and a tube, and thermal insulation covering the exterior sides of the sections and anchored thereon by the studs.

10. In a method of fabricating the wall of a fluid heat exchange device having wall tubes secured to a wall including a section of flat metal disposed exteriorly of the tubes, the method comprising juxtaposing the section and a tube in operative relationship, and securing the wall to the tube by welding through imperforate portions of the wall wholly from positions exteriorly of the wall and on the side of the wall section opposite that side contacted by the tubes and with the addition of metal from similar positions for the separate welds.

11. In a method of fabricating the wall of a fluid heat exchange device having wall tubes secured to a wall including a section of flat metal disposed exteriorly of the tubes, the method comprising juxtaposing the wall and a tube in operative relationship, securing the wall to the tube by welding studs through imperforate portions of the wall wholly from positions exteriorly of the wall and on the side of the wall section opposite that side contacted by the tubes, and disposing thermal insulation exteriorly of the wall by the use of the studs as securing devices.

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