Feb. 4, 1936. T. E. MURRAY 2,029,437

HEAT CONDUCTING TUBE

Original Filed May 23, 1924

Fig. 1.

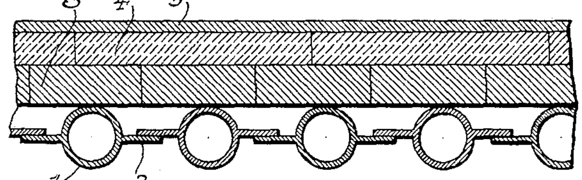


Fig. 2.

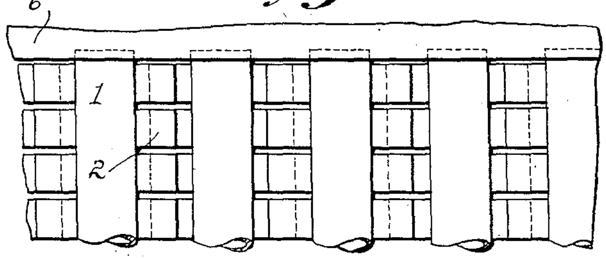


Fig. 3.

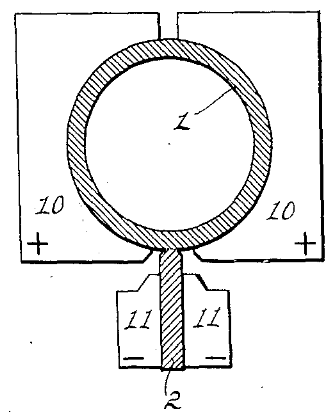


Fig. 4.

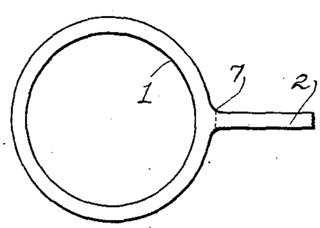


Fig. 5.

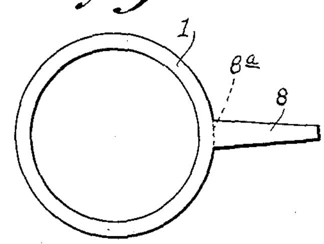


Fig. 7.

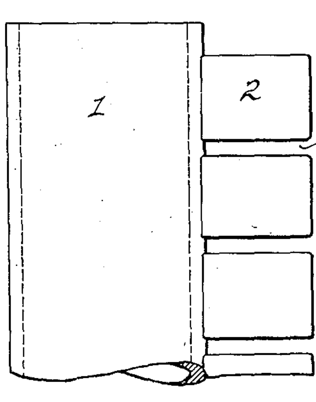
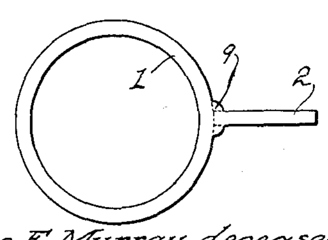


Fig. 6.



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2,029,437

UNITED STATES PATENT OFFICE

2,029,437

HEAT CONDUCTING TUBE

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Original application May 23, 1924, Serial No. 715,369. Divided and this application July 15, 1931, Serial No. 550,903

18 Claims. (Cl. 257—262)

In a previous application No. 715,369, filed May 23, 1924 Patent No. 1,844,407, February 2, 1932, there is described a wall for boilers or heaters and a tubular unit adapted to be used therein having a flange or flanges extending lengthwise thereof so as to provide a heating surface exposed to the heating gases greater than the surface which is in contact with the water or other fluid in the tube. The present application is a division thereof. The accompanying drawing illustrates embodiments of the invention.

Figs. 1 and 2 are respectively a horizontal section and an upper part of an inside elevation of the side wall of a boiler built with the tubular units of the invention.

Fig. 3 is a diagram illustrating a method of production of the flanged tubes.

Figs. 4, 5, and 6 are plans of various forms of unit made in accordance with the invention.

Fig. 7 is a side elevation of the upper end of one of the units.

Referring to Fig. 1, the boiler wall is made with an inner lining or screen comprising tubes 1 with lateral flanges 2 extending across the spaces between the tubes and overlapping each other so as to form a baffle between them. On the outside of this screen is the wall of the boiler structure which may be of any usual or suitable material and which as illustrated comprises refractory blocks or bricks 3 outside of which are tiles 4 of non-conducting material and an outer shell 5 of sheet metal. The longitudinal fins extend throughout such portions of the length of the tubes as may be desired according to the design of the boiler and preferably throughout the zone of radiant heat where their conducting effect is of greatest value. As shown in Fig. 2, they extend substantially up to a header 6 into which the upper ends of the tubes are introduced, leaving the tubes without flanges for a sufficient length to facilitate the making of the joints with the header. The flanges may extend clear down to a similar header below; or may be omitted at the lower end where their cooling effect on the fire bed might be objectionable as illustrated, for example, in the application No. 678,443 filed December 4, 1923 now Patent 1,953,768 of April 3, 1934 and illustrating a boiler wall made with such tubes.

The fins on the tubes serve to transmit heat to the tubes and the water or other fluid therein, and also to protect the masonry or other backing of the wall from the heat of the flame. There is naturally a considerable expansion of the metal by the heat and it varies at different points in the wall. The flanges therefore, while they preferably close the spaces between the tubes by overlapping at their edges, are not secured together but are free to permit relative movement and also to facilitate the repair of the wall in case one or more of the tubes or flanges may be damaged. To conduct the heat more efficiently to the tubes, and to prevent their partial separation from the tubes under the distortion produced by the high temperature, the flanges should make as strong a connection as possible to the tubes and the area of the connection should be fully equal to the section of the flanges. For this purpose I propose to weld the edges to the tubes and to provide a welded area at least equal to and preferably greater than that of the longitudinal section of the flanges.

In Fig. 3 there is illustrated a suitable method of butt-welding a simple flange using the flash welding method or the method described in the Murray Reissue Patent No. 15,466 of October 10, 1922 in which a current of extremely high ampere strength for a very brief regulated period of time is passed through substantially the entire surfaces in contact while the parts are pressed together. The tube 1 is clamped between a pair of positive electrodes 10. The plate 2 is clamped into negative electrodes 11. The plate has its edge which is in contact with the tube slightly beveled. The welding current is passed as explained and the parts are welded firmly with a take-up sufficient to bring the joint to a greater thickness than that of the plate, as shown at 7 in Fig. 4.

Figs. 4 to 6 show a single flange on each tube, and the invention may be applied in this way with the single flange arranged to extend over all or any desired part of the space between two tubes. But, for a given spacing of the tubes, a flange on each side is preferable since it does not have to be so wide as a single flange would and since it provides a shorter distance for conduction of heat through the flange to the tube. Also, instead of making the flanges as in Fig. 1 so wide as to overlap, they may be made of less width and arranged to contact or even to leave a space between their adjacent edges. Also, besides the side flanges illustrated, there may be one or more flanges arranged along the front of each tube, that is, the side of it which is exposed to the furnace gases in order to provide a larger heating surface; and one or more flanges arranged at the back of each tube for connection to the outer part of the wall and for other purposes.

The construction above described is covered in application No. 715,369, now Patent 1,844,407 above referred to. According to the present application the flanges, or one or more of them where a plurality of flanges is employed, are interrupted at intervals in their length. This is particularly advantageous for units of considerable length such as are required in modern high duty boilers, for example. The interrupted construction serves a greater convenience in application of the flange to the tube and is particularly important in that it permits distortion of the units without excessive strain on the welded joints.

The flanges may be of various shapes in cross section. There are a number of standard rolled shapes which are suitable, several of which are illustrated in the aforesaid application No. 715,369 now Patent 1,844,407. There are numerous others that are available.

In Fig. 4, the flange is a common rolled bar or strip of rectangular cross-section and of about the same thickness as the tube and is united by butt-welding at the joint 7. In the welding operation the root area may be increased as shown. The tube is assumed to be ordinary seamless boiler tubing. In Fig. 5, the flange 8 is made of a bar tapered in cross-section with its wider edge butt-welded at 8*a*. This is advantageous in that the increased width tends to compensate for the increased amount of heat that the plate must carry as it approaches the tube and gives greater resistance against sidewise distortion strains at the joint.

In Fig. 6 the flange 2 is made of a bar similar to that in Fig. 4. Instead of butt-welding, however, the arc-welding method is applied to the joint. Metal 9 is deposited by the electric arc and welded to the flange and to the tube over areas which are at least equal to the longitudinal section of the flange and preferably greater to allow for any imperfections. This figure may be taken to illustrate also a butt-weld 7 as in Figs. 4 and 5, supplemented by the arc-welds 9.

A single tube may be used in making up each of the units, but the invention may be equally embodied in units provided with two or more tubes or passages.

The tubes may be ordinary seamless boiler tubing made of low carbon steel or they may be of lap-weld or butt-welded tubing. And, particularly where non-circular cross sections are desired such as are illustrated in previous applications, they can be made of sheet metal lengths stamped into segments and welded together at their edges.

Tubes of the character described are generally of considerable length and of comparatively small diameter, the length being measured in feet and the outer diameter being a few inches, 3 to 5 inches in large installations. The wall thickness is slight compared with the diameter so as to effect a rapid transfer of heat.

The drawing illustrates tubes with a wall thickness about one-twelfth of the diameter. In practice boiler tubes are made even thinner. Standard 4-inch boiler tubes have a wall thickness of one-fourth of an inch or less and the thickness is in increased proportion for larger tubes. The steel used for such tubes is of a certain composition designed to meet the pressures and strains of use and also to permit manufacture by piercing, drawing and rolling in the case of seamless tubes and bending and welding in the case of tubes made from skelp or strips.

The flanged tube of this invention is so constructed as to preserve the original strength and tightness of the tube against leakage under the prevailing conditions of internal pressure. With this aim, the construction is such as to maintain the wall of the tube intact.

The flange is a separate rolled strip or shape which does not involve any break in the continuity of the wall of the tube. The inner edge of the flange member is abutted against the continuous outer surface of the tube. The desired wall thickness is not reduced at any portion of its circumference.

The flanges may be made of ordinary rolled steel. But where they are to be subjected to very high temperatures it is advantageous to use a metal which is better adapted to resist deterioration by oxidation at such temperatures. A number of such metals are known, largely alloys of iron with nickel, chromium and the like. There are also known methods of providing a surface or skin on steel which will resist oxidation, generally by impregnating the surface of the steel with some other metal or alloy. A good example of such a process is that known commercially as calorizing, in which the surface of the steel is given a thin but continuous and very adherent coating or impregnation of aluminum, which is partially alloyed with the steel. Under heat, the aluminum is oxidized, forming a thin continuous adherent coating of alumina which is very effective in resisting further oxidation. This method applies best to rolled steel, but is applicable to almost all other metals. Such a method has this advantage, that the body of the steel retains its original heat conductivity, which is greater than that of most of the resistant alloys of nickel or chromium.

The thickness of the flange should be increased toward the root roughly in proportion to its width in order to theoretically take care of the quantity of heat to be conducted. The actual extent and rate of such increase in thickness would vary with different conditions.

In some locations, particularly where the tube is to be embedded or otherwise firmly held, it is important to guard against buckling or similar distortion owing to the difference in the heating effect on the remote edge of the flange and also on the cooler wall of the tube. It has also been found that in the operation of welding serious strains are set up in the completed unit which tend to warp it in use and even to break or crack the wall of the tube. A 20 foot tube has been found to suffer a decrease of approximately a quarter of an inch in its length in the welding of a continuous flange thereto. By making the flange in separate short pieces the strain is lessened and is distributed evenly throughout the length of the tube, both in the production and in the use of it.

According to the present invention these difficulties are avoided by interrupting the flange at intervals in its length. Fig. 7 shows the flange 2, interrupted at intervals in its length by short spaces 12, extending all the way to the tube. Or such separation of the adjacent parts of the flange may exist for a part of its width, extending inward from the edge sufficiently to meet the circumstances. Each of the flanges or pieces 2 may be of any of the shapes in cross-section above referred to and may be applied by any of the welding methods described, or produced in other suitable ways.

The separate flange members of Fig. 7 may be varied in length (that is, the general direction of the length of the tube) and in the spacing between adjacent members. Satisfactory proportions are shown in Fig. 7 taken in connection with the plan views; the members being in the form of small plates of about the same thickness as the tube wall, of a length about equal to their width or slightly less and of a spacing about equal to their thickness or less.

A suitable machine and method for applying projections to the tubes are described in application Ser. No. 589,347, filed by Hoffer, January 28, 1932.

Electric resistance welding operations of this type are important in order to produce a continuous homogeneous metallic path for conducting the heat from the projection to the tube; that is, a path in which there is no interruption of the continuity and homogeneity of the conducting metal. At the same time resistance welding operations pass the current through the parts to be welded and heat them to a considerable degree. It is this heating of the metal of the tube particularly which sets up the strains referred to hereinabove, and it is for units made by this particular welding method that the present invention has its greatest advantage.

Not only is the tube apt to be distorted by the welding temperature, but also the projection. Such distortion, or tendency to distort, sets up internal strains in the projections. Metal under such internal strain is more readily oxidized than metal in which there is no such strain.

With the comparatively small cross-section projections illustrated herein, there are no substantial internal strains set up. Consequently, they may be made to extend to a much greater width or radial distance from the tubes than where flanges or projections are used of such a size as to be internally strained during the welding operation.

In the present invention the radial dimension of the projections may be determined in advance on the assumption that the metal is not strained substantially and the ends of these projections may be extended to a considerable distance and still be proof against burning away; though with a continuous flange of any substantial length in the axial direction they would not be so.

With the continuous fins of the prior patents, the strains induced by the welding operation have been so great that it has not been safe to cut away any portion of a fin at one side only of a tube because of the strains on the other side. Nevertheless openings through the fins are desirable for peep holes, air passages or the like. This disadvantage is obviated by the present invention.

With the use of separate projections, as in the present unit, one or more of these may be omitted at one side without danger of injury or excessive distortion arising from the provision of projections on the opposite side.

Various modifications may be made by those skilled in the art without departing from the invention as defined in the following claims.

What is claimed is:

1. A tubular unit of the character described adapted to be exposed externally to high temperatures and to carry a liquid to be heated, constituting a complete unitary article of manufacture and consisting of a long steel tube of small diameter compared with its length and of small wall thickness compared with its diameter and separately formed flange members each of which is of less length than the tube and has a free outer edge and each of which is separately welded at its inner edge to said tube, said flange members being in longitudinal alinement with each other parallel with the axis of the tube and being separated from one another by short intervals.

2. A tubular unit of the character described adapted to be exposed externally to high temperatures and to carry a liquid to be heated, constituting a complete unitary article of manufacture and consisting of a long steel tube of small diameter compared with its length and of small wall thickness compared with its diameter and separately formed flange members each of which is of less length than the tube and has a free outer edge and each of which is separately welded at its inner edge to said tube, said flange members being separated from one another by short intervals, the thickness of the welded unit at the root of the flange being greater than at the outer edge of the flange.

3. A tubular unit of the character described adapted to be exposed to high temperatures and to carry a fluid to be heated, constituting a complete unitary article of manufacture and consisting of a long steel tube of small diameter compared with its length and of small wall thickness compared with its diameter, and a line of separately formed projecting members each of which is of comparatively short length and has a free outer edge and each of which is separately welded at its inner edge to said tube, said projecting members being separated from one another by short intervals so that the line of such members forms an interrupted flange on the outside of the tube.

4. A tubular unit of the character described adapted to be exposed to high temperatures and to carry a fluid to be heated, constituting a complete unitary article of manufacture and consisting of a long steel tube of small diameter compared with its length and of small wall thickness compared with its diameter, and projecting members composed of separate small plates of about the same thickness as the tube wall, of a width less than the diameter of the tube and of a length (in the general direction of the length of the tube) about equal to their width, each of said members being separately welded to said tube.

5. A tubular unit of the character described adapted to be exposed to high temperatures and to carry a fluid to be heated, constituting a complete unitary article of manufacture and consisting of a long steel tube of small diameter compared with its length and of small wall thickness compared with its diameter, and projecting members composed of separate small plates of about the same thickness as the tube wall, of a width less than the diameter of the tube and of a length (in the general direction of the length of the tube) about equal to their width, each of said members being separately welded to said tube, said members being separated at their welded edges by a distance about equal to their thickness or less.

6. A tubular unit of the character described adapted to be exposed externally to high temperatures and to carry a liquid to be heated, consisting of a long steel tube of small diameter compared to its length and of small wall thickness compared to its diameter and a plurality of heat-conducting extension members welded to the outside of the tube at points spaced apart from one another and adapted to transmit heat to the tube and thence to the liquid within, said extension members being in two groups opposite to each other and separated from each other by approximately half the circumference of the tube, the circumference being bare between said opposite groups.

7. For a water wall exposed to radiant heat at a side of a combustion chamber, a tube provided with a series of separate longitudinally extending and aligned fin-like projections secured thereto at opposite sides thereof, the ends of said sections being spaced slightly from each other to compensate for irregularities in expansion and contraction in portions of said sections adjacent to the tube as compared with portions thereof remote from the tube, but said sections being disposed in sufficient proximity to each other, lengthwise of the tube, to provide a substantially unbroken furnace chamber wall.

8. A water tube of the character described having a series of separate longitudinally extending and aligned fin-like projections secured thereto, the ends of said sections being slightly spaced from each other to provide for irregularities in expansion and contraction of said projections in portions thereof remote from the tube as compared with portions thereof adjacent to the tube, but said projections being disposed in such manner as to provide a substantially unbroken furnace chamber wall when used in combination with other similarly arranged tubes.

9. A tube for the heating and circulating of water or other fluid, said tube having a series of numerous separate projections forming extended heating surfaces, each being united directly to said tube by a separate electric resistance weld providing a continuous homogeneous metallic path for conducting heat, each weld having an area small enough to permit application of the projection without substantial strain upon or deformation of the tube and the projection by the welding operation or under subsequent exposure to high temperatures and the projections being applied over substantially the entire exposed length of the tube and having their outer ends free so that they can expand separately under heat, whereby the unit is adapted to stand exposure to high temperatures without injury and the projections are proof against burning away at ends remote from the tube.

10. In a boiler wall construction, a multiplicity of upright tubes connected into the circulation of the boiler spaced apart from one another and connected at their ends, and metallic members extending substantially across the spaces between said tubes and consisting in each space of a series of comparatively small members separate from each other in heat conducting engagement with the tubes and slightly spaced apart so that they can expand separately under heat.

11. The combination of a plurality of heat conducting units for boilers, each unit comprising a long small-diameter thin-walled steel boiler tube, each having at least one longitudinally extending series of small projections separate from each other and welded to the tube with their outer edges free.

12. A tube for the heating and circulating of water or other fluid, said tube having a series of separate projections on its exterior forming extended heating surfaces, each projection having a width (transverse to the tube axis) which is at least as great as its length (parallel to the axis) at its tube-engaging end, each projection being united directly to the tube by a separate electric resistance weld providing a continuous homogeneous metallic path for conducting heat, each weld having an area small enough to permit application of the projection without substantial strain upon or deformation of the tube and the projection by the welding operation or under subsequent exposure to high temperatures and the projections being applied over substantially the entire exposed length of the tube and having their ends free so that they can expand separately under heat, whereby the unit is adapted to stand exposure to high temperatures without injury and the projections are proof against burning away at ends remote from the tube.

13. A tube for the heating and circulating of water or other fluid, said tube having a series of numerous separate projections forming extended heating surfaces, each being united directly to said tube by a separate electric resistance weld providing a continuous homogeneous metallic path for conducting heat, each weld having an area small enough to permit application of the projection without substantial strain upon or deformation of the tube and the projection by the welding operation or under subsequent exposure to high temperatures and the projections being applied over substantially the entire exposed length of the tube and having their outer ends free so that they can expand separately under heat, said projections being spaced as closely to each other as is practicable without interference when heated, whereby the unit is adapted to stand exposure to high temperatures without injury and the projections are proof against burning away at ends remote from the tube.

14. The tube of claim 9, the projections being parallel with each other and the series of projections being in a line parallel to the axis of the tube.

15. The tube of claim 9, the projections being of approximately rectangular cross-section with their faces extending lengthwise of the tube.

16. A tubular unit of the character described adapted to be exposed externally to high temperatures and to form part of the circulating system of a boiler, constituting a complete unitary article of manufacture and consisting of a long steel tube of small diameter compared with its length and of small wall thickness compared with its diameter and separately formed outward projections, separately welded at their inner ends to the tube and separated from one another by short intervals, said projections having a width (transverse to the tube axis) which is at least as great as half the diameter of the tube, the outer ends of the projections being free so that they may expand separately under heat and the welded area being so proportioned to the width as to avoid introducing substantial internal strains on the tube and projection and to suffice for transferring to the tube the heat absorbing capacity of the projection.

17. A tube for the heating and circulating of water or other fluid, said tube having a smooth

interior for unobstructed circulation of the water and having numerous separate projections on its exterior forming extended heating surfaces, said projections being spaced as closely to each other as is practicable without interference when heated and expanded, so as to provide a substantially unbroken wall.

18. A tube for the heating and circulating of water or other fluid, said tube having numerous separate projections on its exterior forming extended heating surfaces, said projections having small ends welded to the tube so as to avoid the occurrence of substantial strains from the tube and projections and said projections being spaced as closely to each other as is practicable without interference when heated and expanded, so as to provide a substantially unbroken wall.

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