Jan. 19, 1937. W. Y. LEWIS 2,068,187

HEAT TRANSFER APPARATUS APPLICABLE TO WATER TUBE BOILERS

Filed Feb. 18, 1935 3 Sheets-Sheet 1

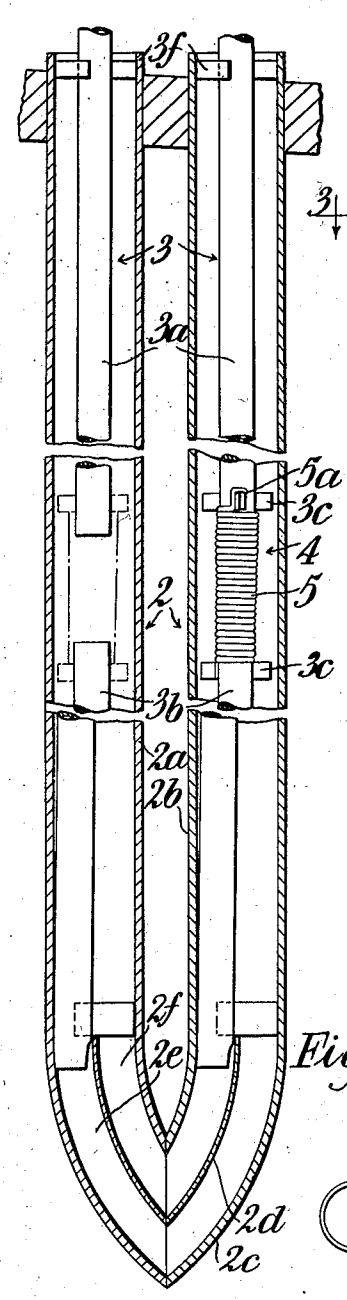


Fig 1

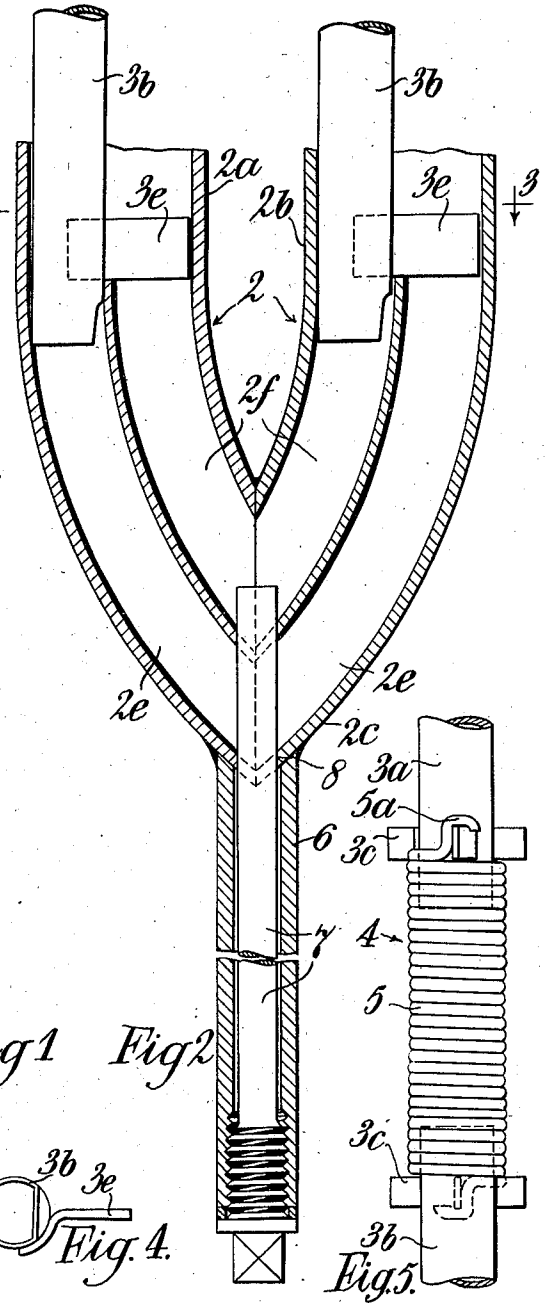


Fig 2

Fig. 4.

Fig. 5.

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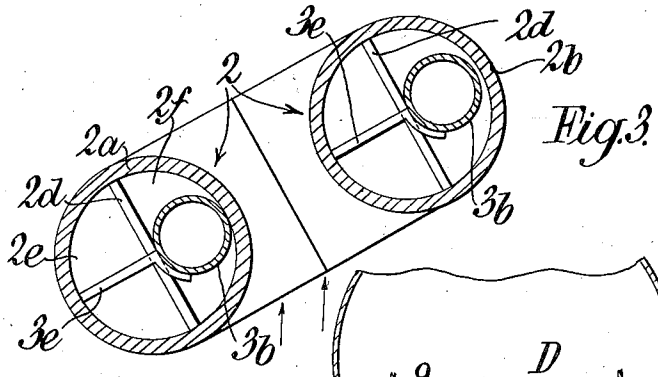


Fig. 3.

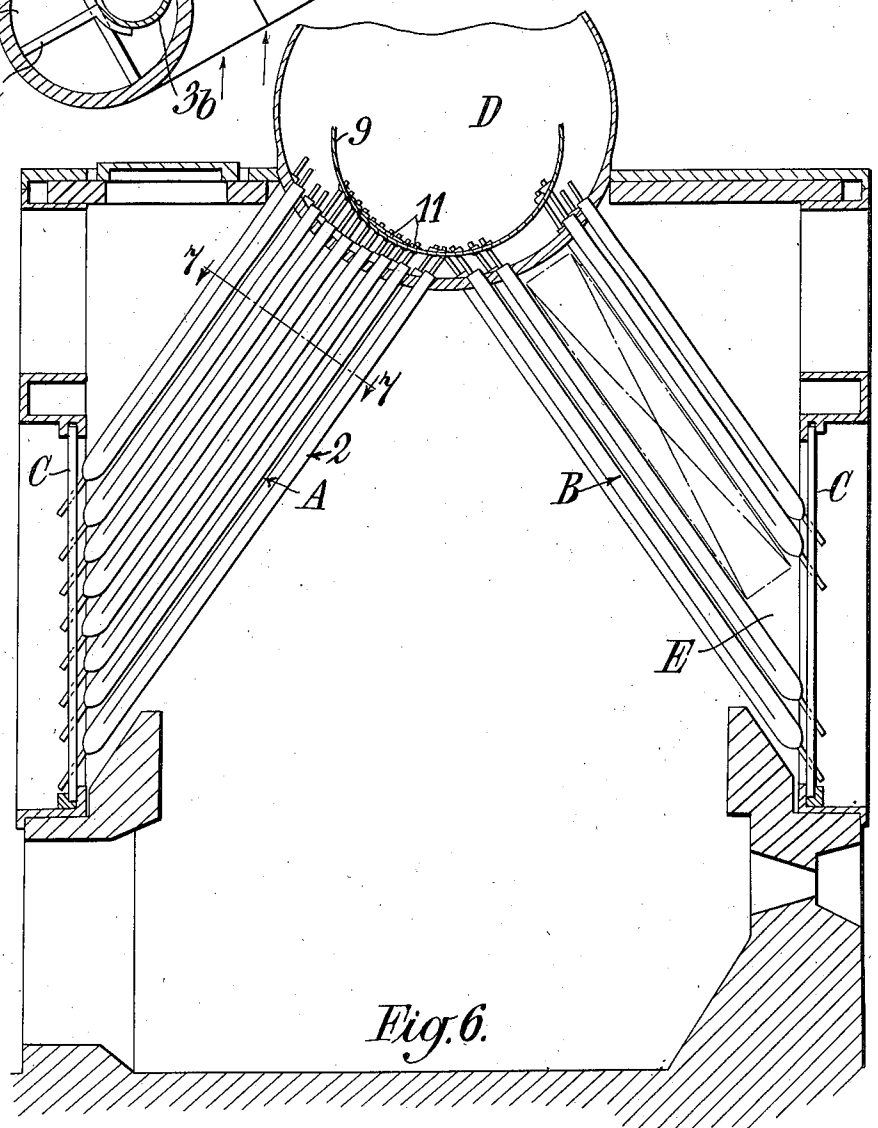


Fig. 6.

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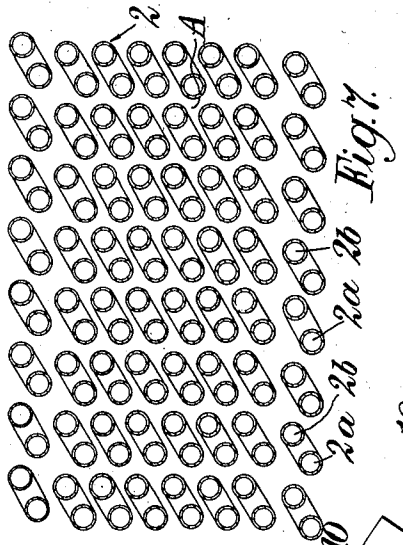


Fig. 7.

Fig. 8.

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Patented Jan. 19, 1937 2,068,187

UNITED STATES PATENT OFFICE

2,068,187

HEAT TRANSFER APPARATUS APPLICABLE TO WATER TUBE BOILERS

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Application February 18, 1935, Serial No. 7,091
In Great Britain February 21, 1934

20 Claims. (Cl. 122—312)

The invention relates to heat-transfer apparatus and is particularly applicable, though not restricted, to water-tube steam generators of the kind described in my prior U. S. Patent No. 2,008,076 having U-Field-tube units.

In this specification, arrangements are shown for ensuring a directed circulation at the bend of the U.

Such arrangements, though well suited to bends of considerable radius, are not applicable when the legs of the U's have to be brought close together in order to secure as large a heating surface as possible in a given space, and a main object of the present invention is to provide improved means for directing the circulation which will be suitable for bends of small radius and also facilitate the assembly of the U-Field-tube unit.

Further objects of the invention are to provide improved means for positioning the inner tubes of the Field-tube units and to facilitate their introduction into the U's when the drums or the like to which they are attached are of small dimensions transversely as compared with the length of the tubes, and with such objects the present invention consists in the heat-transfer units and combinations of elements constituting heat-transfer apparatus hereinafter described and particularly pointed out in the claims.

Referring to the accompanying drawings, which are of a somewhat diagrammatic nature:—

Figure 1 shows an elevation partly in section of one form of U-Field-tube unit according to the present invention,

Figure 2 showing a longitudinal section of the U-bend to a larger scale, and

Figure 3 a cross-section on the line 3—3 of Figure 2 showing the disposition of the unit in relation to the source of heat;

Figure 4 is a view looking on the end of one of the inner tubes in Figure 2 showing locating fin;

Figure 5 shows an elevation of a form of spring coupling for detachably connecting aligned lengths of inner tube;

Figure 6 shows an end elevation partly in section of a water-tube steam generator fitted with U-Field-tube units according to the present invention,

Figure 7 being a cross-section on the line 7—7 of Figure 6 showing the angled position of the U's; and

Figure 8 a cross-section of part of the steam-and-water drum to an enlarged scale showing the attachment or location of the inner and outer tubes of the units.

When desirable the same reference symbols are used in the different drawings to denote corresponding parts.

In carrying the invention into effect according to one form, (see Figures 1 and 2) a heat-transfer unit takes the form of a U-tube, 2, with legs, 2*a*, 2*b*, and downcomer inner tubes, 3, 3, disposed therein.

The bend, 2*c*, of the U of such a U-Field-tube unit is provided with a central diaphragm or partition, 2*d*, disposed longitudinally so as to provide at this point two ducts or passages, 2*e*, 2*f*.

According to one method, the U-tube, 2, is built up, in a well-known manner, from two symmetrical halves slightly curved at the bend and united as by welding so as to form a so-called spearhead, but before the two halves are united, the diaphragm, 2*d*, above-mentioned is inserted, half in one leg and a separate aligned half in the other, and secured in place, as by spot-welding.

Or alternatively, the diaphragm, 2*d*, may be in one piece; or again it may be in the plane of the U.

By these means, a spearhead U is obtained with a diaphragm, 2*d*, disposed longitudinally round the bend.

In order to facilitate assembly of the unit, each inner tube, 3, 3, comprises in general two lengths of tube, 3*a*, 3*b*, connected by a suitable union, 4.

According to one form, such a union takes the form of a close-wound helical coil, 5, (see Figure 5) of spring wire of circular cross-section, adjacent convolutions of the coil in its unstrained state touching one another throughout their length.

Each coil is proportioned to be a neat fit over the ends of the adjacent lengths of tube it connects and may if necessary be secured in place so as to withstand a certain amount of tension by any suitable means.

Thus, according to one plan, webs or fins, 3*c*, may be fixed as by spot welding to the adjacent ends (or one of them) of the lengths of inner tube, 3*a*, 3*b*, to be connected, the fins serving as spiders centralizing them in the outer tubes while the connecting coil, 5, is bent over at its ends as at 5*a*, so that it may be readily hooked over the corresponding webs or fins, 3*c*.

If desired, the wire may be coated or plated, e. g., with cadmium or zinc, to prevent corrosion.

The bottom of the U-tube, 2, is provided with a tail, 6, to assist in locating the unit, this tail being very conveniently made hollow and, if desired, fitted with a screwed plug, 7, passing through the diaphragm to tap water in the duct,

2*f*, of smaller radius, and passing also through a hole, 8, in the wall of the U-bend to permit escape of water that has collected in the duct, 2*e*, of larger radius.

Or alternatively, a small clearance may be left between the two halves of the diaphragm, or a hole made in the lower part of the diaphragm when of one piece, so that any water in the inner duct, 2*f*, may pass through to the outer duct to be drained off, passage of the plug, 7, through the diaphragm being in this case eliminated.

As regards the position of the inner tubes, 3, 3, with regard to the two ducts, 2*e*, 2*f*, provided by the diaphragm, 2*d*, round the U-bend, in general, e. g., in a water-tube steam generator to be described below, each U-Field-tube unit as a whole is arranged with its length at an angle to the horizontal and is heated from below; in addition the plane of the U may also lie at an angle oblique to the axis of the steam-and-water drum. In such cases, (see Figure 3) in order to prevent overheating of the inner tubes and thus interfere with their function as downcomers, they are preferably arranged to enter the particular duct on that side of the bend remote from the source of heat, the direction in which heat therefrom reaches the unit being indicated by the arrows.

The inner tubes, 3, 3, at their lower ends may each be provided with a pin or web, 3*e*, to rest on the relevant edge of the diaphragm, 2*d*, while at their upper ends, they may be provided with other fins or webs, 3*f*, resting on the open ends of the U-legs.

Another method of positioning the upper ends of the inner tubes is described below.

In the application of U-Field-tube units in accordance with the present invention to a steam generator, e. g., of the Yarrow type, banks, A, B, of U-Field-tube units forming the legs of an inverted V, are provided in the usual position in Yarrow-type steam generators as described in the specification above identified, lower water drums being omitted, and the lower ends of the units being supported in positioning frames, C, by help of their locating tails, 6.

As shown in Figure 8, the open ends of the U's are secured, as by expanding, to the lower wall of the steam-and-water drum, D. A space, E, as indicated may be left in the bank of tubes to accommodate a superheater.

At the upper end of each U-Field-tube unit, the inner tube, 3, passes out of the outer tube and is secured to a curved locating plate, 9, disposed within the steam-and-water drum. This plate, before bending, is provided with appropriately pitched holes, 10, 10, so that when bent into a cylindrical or other appropriate form, the holes are suitably disposed for receiving the upper ends of the more or less parallel inner tubes, 3, 3, of the U-Field-tube units.

The upper end of each such inner tube, which may be circular as described above, semi-circular, oval or any other shape in cross-section, passes freely through a hole of similar shape in a spherical segment, 11, seated in the appropriate hole, which is preferably chamfered to receive it. The upper part of the sphere, say for one-quarter of its diameter, is cut away by a plane, 12, at right angles to the axis of the inner tube, and it is one advantage of the spherical joint under description that the length of inner tube, 3, projecting beyond the plane face, 12, of the spherical segment serves to indicate if the lower end of the tube has entered one of the ducts, 2*e*, 2*f*, round the bend of the U, and if so, to what extent.

It will be understood that the spherical segments, 11, which may be of cast iron or any other cheap heavy metal, are maintained in position by their own weight and in view of the fact that the pressure is practically equal on the two sides of the division plate, 9, a sufficiently good joint is thus obtained in a very simple manner.

In order to prevent the possibility of a downward flow in the outer tubes, each outer tube at its upper end may be provided with a thin plate, 13, having a hole, 14, through which the inner tube, 3, freely passes, the plate being of sufficient size to cover the end of the outer tube in all positions. Such a plate serves as a simple form of valve which allows the steam generated to issue from the upper end of the outer tube but immediately closes on any reversal of flow taking place.

In some cases, the spherical attachment of the inner tubes above described is provided for only a certain number of the Field-tube units; thus, for example, the inner tubes of a bank of U's on the side thereof remote from the furnace, where their angle to the division plate becomes very acute may extend a certain distance from the outer tubes as at 3*g*, Figure 8, without any kind of attachment to the locating plate, 9, the tubes in such a case having fins, 3*f*, to centre or otherwise define their position in the mouth of the outer tubes.

In a water-tube steam generator as described, and with inner tubes of about half-an-inch or five-eighths of an inch in diameter, a connecting coil, 5, as shown in Figure 5, say two or three inches long, of a wire of suitable gauge and quality, will enable adjacent lengths of tube, 3*a* 3*b*, to be bent at right angles to one another so that it may readily be introduced endwise into the drum and then turned at a right angle for insertion in the outer tubes.

Improved U-Field-tube units in accordance with the present invention may be arranged in only the fire row or rows of the boiler, the rows more remote from the combustion chamber being of simplified construction, say, without the diaphragm or with an inner tube in only one leg.

Many variations may be made in the details of construction above described without exceeding the scope of the invention as defined in the accompanying claims.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. A U-Field-tube heat-transfer unit comprising a U-tube having a bend at that part remote from the ends of its legs, a diaphragm running longitudinally round said bend to provide separated ducts in said bend and at least one inner tube inserted in said U-tube and operatively aligned with one of said ducts.

2. A U-field-tube heat-transfer unit as claimed in claim 1, in which said diaphragm is disposed at right angles to the U-plane of said U-tube.

3. A U-Field-tube heat-transfer unit as claimed in claim 1, in which the inner tube is supported by an edge of said diaphragm.

4. A U-Field-tube heat-transfer unit as claimed in claim 1, with a web secured to the inner tube, said web being supported by an edge of said diaphragm.

5. As an article of manufacture, a U-tube for a U-Field-tube heat-transfer unit having a bend at that part remote from the ends of its legs and

a diaphragm running longitudinally round said bend to provide separated ducts therein.

6. As an article of manufacture, a U-tube as claimed in claim 5, in which said diaphragm is integral with said U-tube.

7. As an article of manufacture, a U-tube as claimed in claim 5, in which said diaphragm is disposed at right angles to the U-plane of said U-tube.

8. As an article of manufacture, a U-tube as claimed in claim 5, in which the diaphragm is disposed at right angles to the U-plane of said U-tube with an aperture in the outer wall of said bend and a hollow U-tube-locating tail secured to said bend and communicating with the interior thereof by way of said aperture, said diaphragm having an aperture aligned with said first-mentioned aperture, together with a detachable draining plug inserted in said tail and passing through said aligned apertures.

9. As an article of manufacture, a U-tube as claimed in claim 5, in which the diaphragm is disposed at right angles to the U-plane of said U-tube with an aperture in the outer wall of said bend and an aligned aperture in said diaphragm and means passing through said aligned apertures for draining from the separated ducts determined by said diaphragm.

10. A Field-tube steam generator comprising a steam-and-water receptacle and a series of Field tubes in operative association therewith and running in a downward direction therefrom, each of said Field tubes comprising an outer tube secured to said receptacle and at least one inner tube disposed in said outer tube, said inner tubes comprising at least two lengths of rigid tube and a flexible coupling composed of a close-wound helical coil of spring wire connecting said lengths.

11. A Field-tube unit, comprising an outer tube and at least one inner tube inserted therein, said inner tube comprising at least two lengths of rigid tube and a flexible coupling composed of a close-wound helical coil of spring wire connecting said lengths.

12. A Field-tube unit as claimed in claim 11, in which said flexible coupling is detachable from said united lengths of tube.

13. A Field-tube unit, comprising an outer tube and at least one inner tube inserted therein, said inner tube comprising at least two lengths of rigid tube, and a flexible union connecting said lengths, said union having an intermediate part consisting of a helical coil of spring wire close wound to confer fluid-tightness and end parts for securing said intermediate part to said lengths of tube.

14. A Field-tube unit, comprising an outer tube and at least one inner tube inserted therein, said inner tube comprising at least two lengths of rigid tube, and a flexible union connecting said lengths, said union having an intermediate part consisting of a helical coil of spring wire close wound to confer fluid-tightness and end parts for securing said intermediate part to said lengths of tube, said end parts being integral continuations of the convolutions of said intermediate part.

15. A Field-tube unit, comprising an outer tube and at least one inner tube inserted therein, said inner tube comprising at least two lengths of rigid tube, and a flexible union connecting said lengths, said union having an intermediate part consisting of a helical coil of spring wire close wound to confer fluid-tightness and end parts for securing said intermediate part to said lengths of tube, said lengths of tube having complementary securing means with which said end parts are operatively associated.

16. A heat transferrer comprising a receptacle and a plurality of U-Field-tube heat-transfer units as claimed in claim 1 associated therewith, said U-tubes being secured to the wall of said receptacle, a plate with apertures disposed within said receptacle and means for positioning said inner tube in said plate, said positioning means comprising a plurality of apertured packings through which said inner tubes pass, said packings having spherical parts seated in said plate apertures.

17. A heat transferrer comprising a receptacle and a plurality of U-Field-tube heat-transfer units as claimed in claim 1, associated therewith, said U-tubes being secured to the wall of said receptacle, a plate with apertures disposed within said receptacle and means for positioning said inner tubes in said plate, said positioning means comprising a plurality of apertured packings through which said inner tubes pass, said packings having spherical parts seated in said plate apertures, and having also a flat surface at right angles to the axis of the inner tube passing through said packing.

18. A heat transferrer comprising a receptacle and a plurality of U-Field-tube heat-transfer units as claimed in claim 1, associated therewith, said U-tubes being secured to the wall of said receptacle and projecting a certain distance into the interior of said receptacle and non-return means for preventing flow of fluid from the interior of said drum into the annulus between a U-leg and the inner tube disposed therein.

19. A heat transferrer comprising a receptacle and a plurality of U-Field-tube heat-transfer units as claimed in claim 1 associated therewith, said U-tubes being secured to the wall of said receptacle and projecting a certain distance into the interior of said receptacle and non-return means for preventing flow of fluid from the interior of said drum into the annulus between a U-leg and the inner tube disposed therein, said non-return means comprising a member seatable on the end of an outer tube projecting into said receptacle, said member having an aperture therein through which the associated inner tube passes.

20. A steam generator having a source of heat, a steam receptacle and a plurality of U-Field-tube heat-transfer units as claimed in claim 1, associated therewith, with said U-tubes secured to the wall of said receptacle, said U-tubes being so disposed that one leg of said U and the inlet to one of said ducts associated with that leg is more remote from said source of heat than the other of said legs, said inner tubes being respectively aligned with the inlets to said ducts more remote from said source of heat.

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