Feb. 26, 1952 G. ROSSI 2,587,530

WATER AND FIRE TUBE FOR STEAM BOILERS

Filed March 14, 1949 2 SHEETS—SHEET 1

Fig. 1.

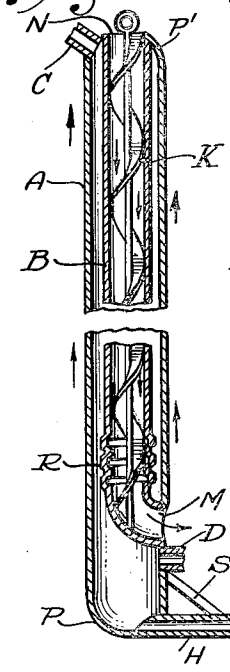


Fig. 2.

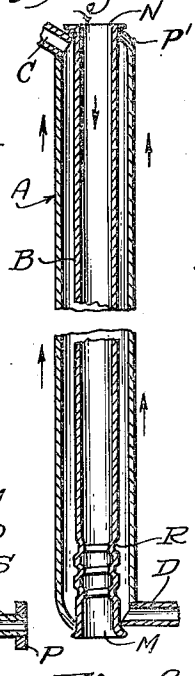


Fig. 3.

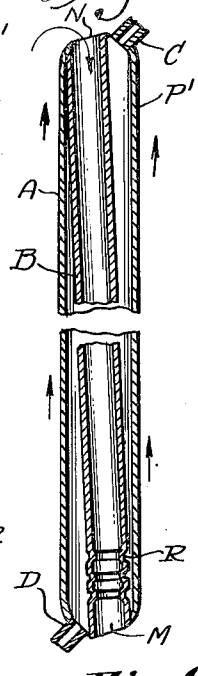


Fig. 4.

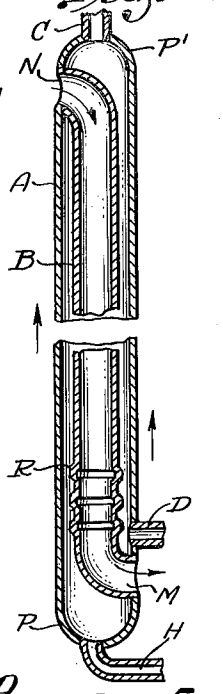


Fig. 6.

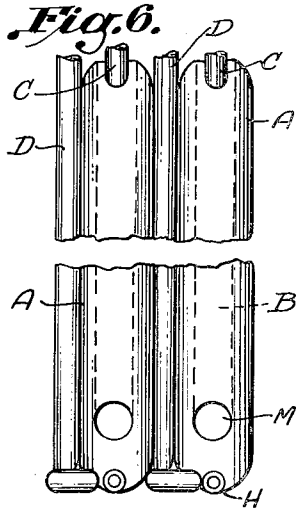


Fig. 8.

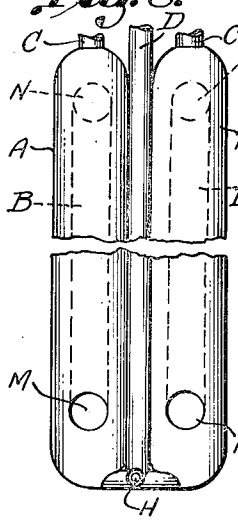


Fig. 9.

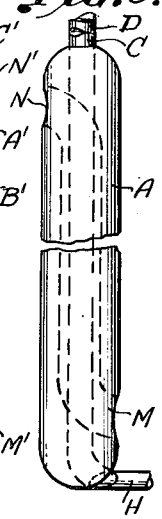


Fig. 5.

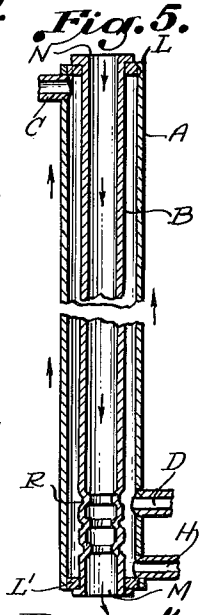


Fig. 7.

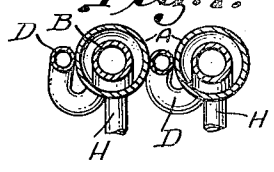
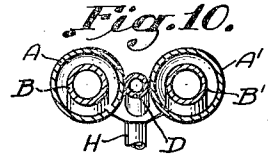


Fig. 10.



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Fig. 11.

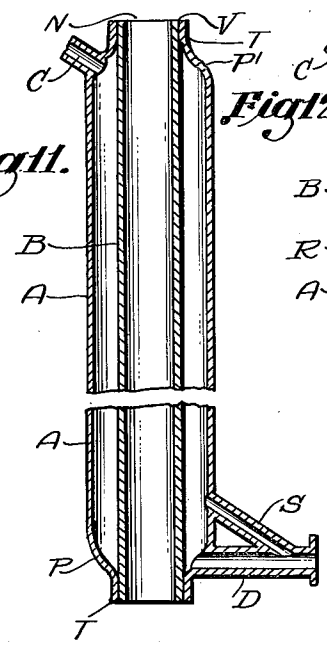


Fig. 12.

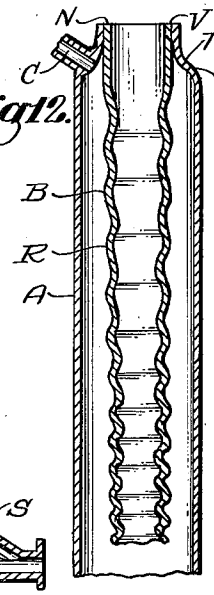


Fig. 13.

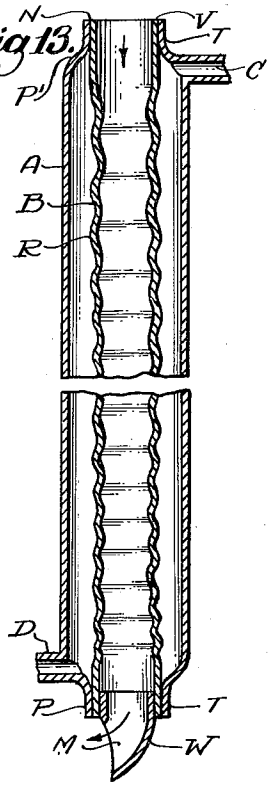


Fig. 14.

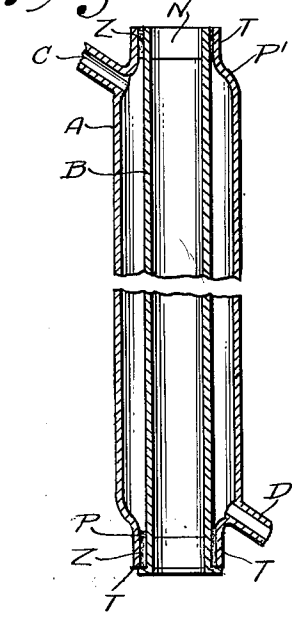


Fig. 15.

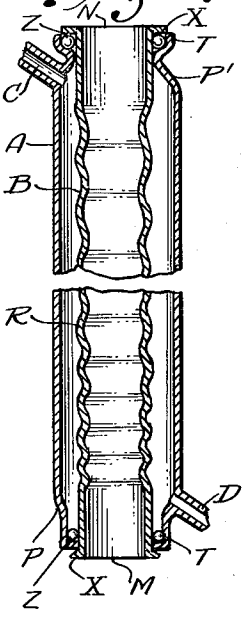
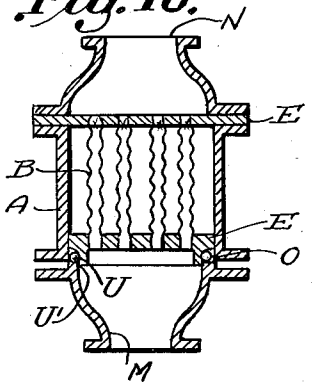


Fig. 16.



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2,587,530

WATER AND FIRE TUBE FOR STEAM BOILERS

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2 Claims. (Cl. 122—114)

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The present invention relates to a water and fire tube for a steam boiler or other heat exchanger.

One of the objects of the present invention is to provide a water and fire tube element of the above type which increases the turbulence of fluids flowing therethrough as the temperatures of these fluids decrease so as to heighten the heat exchange between these fluids during such periods of temperature decrease.

Another object of the present invention is to provide water and fire tube elements of the above type which may be easily added to or removed from a heat exchanger to vary the capacity thereof.

With the above objects in view, the present invention mainly consists of a water and fire tube element comprising an outer elongated tubular body formed with inlet and outlet openings adjacent opposite ends thereof, respectively. An inner tubular body is located within this outer tubular body, extends in the longitudinal direction thereof, and has opposite open inlet and outlet portions which pass through the wall of the outer tubular body, this inner tubular body being at least partially formed with a plurality of annular corrugations which are spaced from each other by progressively decreasing distances in the direction from the inlet end portion to the outer end portion of the inner tubular body. Where the corrugations do not extend over the entire length of the inner tubular body, it is preferred that they be located adjacent to the outlet end portion of the inner tubular body.

The outer tubular body may carry water and steam therethrough in counterflow to hot gases passing through the inner tubular body. The above-mentioned corrugations, in addition to enhancing the heat transfer between the fluids also serve to compensate for deformations resulting from thermal expansions and contractions of the inner tubular body. A separate helicoidal diaphragm may be located within the inner tubular body in order to create further turbulence of the gases so as to thereby improve the heat exchange between the fluids.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

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Fig. 1 illustrates an elevational, partially sectional view of one possible embodiment of a water and fire tube element construction in accordance with the present invention;

Figs. 2–5 are elevational, sectional views of different embodiments, respectively, of the structure illustrated in Fig. 1;

Fig. 6 is an elevational, fragmentary view of one possible manner in which a plurality of water and fire tube elements of the present invention may be combined;

Fig. 7 is a partially sectional, plan view of the structure shown in Fig. 6;

Fig. 8 is an elevational, fragmentary view of another possible manner in which a plurality of water and fire tube elements of the present invention may be combined together;

Fig. 9 is a side view of the structure shown in Fig. 8;

Fig. 10 is a partially sectional, plan view of the structure shown in Fig. 8;

Figs. 11–15 are elevational, sectional views of still further embodiments, respectively, of water and fire tubes constructed in accordance with the present invention; and

Fig. 16 is a diagrammatic sectional view of a boiler including tubes constructed in accordance with the present invention.

Referring now to the drawings, there is shown in Fig. 1 a water and fire tube construction which includes the outer tubular body A having the inner tubular body B mounted therein and forming a smoke tube for hot gases, while tube A forms a water tube. The tube A is provided at its opposite ends, respectively, with the tubes C and D, tube C being the outlet for the water and steam and the tube D forming an inlet for the water. The hot gases enter through the top part of tube B, shown in Fig. 1, and discharge from the lower part thereof, so that the hot gases and water flow in countercurrent to each other, as shown by the arrows in the drawings. The structures illustrated in Figs. 1 and 4 to 10 are provided with an outlet means H, as shown in the drawings, to permit the cleaning and removal of sediment from the water tube A.

In the construction illustrated in Fig. 1, the upper opening N of the tube B is located coaxially with the tube A and the edge portion of the opening N is fixed to the spherically-shaped end P' of the body A by means of soldering, for example. The lower end M of the tube B is laterally bent so that it passes laterally through the wall of tube A, and the gases flow in the direction of the arrows. Within the tube B there is

located the helicoidal diaphragm K mounted on a central supporting rod. This helicoidal diaphragm K provides a turbulent flow in the hot gases so as to improve the heat transfer between the fluids. Diaphragm K may be easily removed, for cleaning purposes, by slipping it upwardly and outwardly of the tube B.

In order to prevent excessive stresses in the tube B because of deformations due to thermal contraction and expansion, the tube B is formed with peripheral, annular corrugations R which automatically compensate for the expansions and contractions to which the tube B is subject. These corrugations are preferably located adjacent the outlet end of the tube B so that these corrugations will produce a further turbulence in the gas, after it has given up the greater part of its heat in the upper portion of the tube B, for the purpose of increasing the heat transfer from these relatively cool gases located adjacent the outlet end of the tube B.

In the embodiment of the invention which is illustrated in Fig. 2, the openings N and M are coaxial with each other and with the axis of the tube A. This arrangement in addition to permitting an easier and more efficient cleaning of the structure, also permits the tube B to be fastened to the tube A by spreading the ends of the tube B outwardly, as shown in Fig. 2.

In the embodiment of Fig. 3, the ends N and M of the tube B are also coaxial with each other, but in this embodiment the axis of the tube B is inclined to that of the tube A in order to improve the circulation of the water and steam.

In the embodiment of Fig. 4, the tube A is provided with spherical ends P and P', and both ends N and M of the tube B are laterally bent in opposite directions and pass through the wall of the tube A.

In the structure of Fig. 5, the tube A is closed at its ends by the perforated plate members L and L' which are fastened to the ends of the tube A by soldering, for example. The ends N and M of the tube B pass through the perforated plates L and L' and are expanded, as shown in Fig. 5, so as to fixedly join the tube B to the plates L and L'. The tubes C, D and H are fastened to the wall of tube A of the embodiment of Fig. 5 by any suitable means, such as soldering or expanding, and these tubes all pass through the wall of the tube A.

Figs. 6 and 7 illustrate one manner in which a plurality of the above-described water and fire tube elements may be joined to each other. In the arrangement of Figs. 6 and 7, the downcomers D for leading the water to the bottom of the tube A are located between adjacent tubes A so as to form a wall with the latter. In Figs. 8 to 10 there is illustrated a variation of the arrangement of Figs. 6 and 7, in that the single tube D located in the tubes A and A' simultaneously supplies both of these tubes. Also, the arrangement of Fig. 6 includes separate sediment outlets H, whereas the arrangements of Figs. 8 to 10 include a single sediment outlet H common to a pair of adjacent tubes A.

In the structure illustrated in Figs. 11 to 15, the outer tubular body A has its opposite ends P and P' tapered so as to each form a collar T which retains an end of the inner tube B mounted coaxially within the tube A. In Figs. 11 to 13, the ends of the tubes B are cylindrical and the collars T retaining these ends are also cylindrical. The tubes B are mounted with a tight, press fit in the collars T, so that the soldering

seam V located at the outer ends of the adjoining tubular bodies only serves the purpose of eliminating possible small losses by providing a more perfect seal, the mechanical stresses resulting from internal pressures being absorbed by the tubes A and B. When it is necessary to remove the sediment from the inside of tubular body A, all that is required is the removal of the solder V by filing, grinding or melting, so that the inner tube B may be easily pushed out to give access to the interior of tube A. After the sediment has been removed, tube B may be easily replaced and again soldered in its original position. This latter operation may be repeated as many times as desired.

In Fig. 12 the internal tube B is provided with corrugations R which progressively increase in depth in the direction from the top to the bottom of the tube B, so that, as the temperature of the hot gases decreases, the turbulence thereof is increased so as to increase the heat exchange with the decreased temperature of the gases. The corrugations R may be formed of individual annular corrugations or of a single helicoidal corrugation. If desired, the variation in the amount of turbulence may also be obtained by progressively varying the pitch of the corrugations along the tube B, as shown in Figs. 13 and 15 where the distances between adjacent corrugations gradually decrease toward the lower end of the tube B.

The supply tube D provides a support for the construction shown in Fig. 11, for example, when the latter is arranged with its axis extending in a vertical direction, and the tube D has connected thereto the brace S which is preferably tubular so as to provide for water circulation through the elements S and D for the purpose of preventing deterioration of the brace S when in contact with the hot gases. As is shown in Fig. 13, the bottom opening M of the gas tube B is joined to a curved tube W for discharged gases, which are thus directed transversely in a direction away from the furnace wall which may be formed by several of the tube constructions shown in Fig. 13, as described above in connection with Figs. 6 to 10.

In the arrangement illustrated in Fig. 14, the seal between the tubes is obtained by means of a pair of metallic packing rings Z, which may be made of copper, for example. These rings Z are each pressed between the adjoining ends of the bodies A and B, these ends preferably being cone-shaped so as to permit the packings Z to be pressed. To prevent the inner tube B from slipping out in an upward direction, its lower peripheral end is spread outwardly, as shown in Fig. 14, or it may be soldered to tube A, as shown in Figs. 11 to 13.

In Fig. 15, the packing rings Z are respectively pressed between the end collars of the tube B and the bell-shaped ends T of the tube A. The lower ends of tube B may be spread outwardly in the embodiment of Fig. 15 also, to prevent upward slipping of the tube B.

Fig. 16 diagrammatically illustrates a heat exchanger provided with several corrugated tubes B of the type described above. These tubes B are each connected at their opposite ends to the plates E, respectively, the upper plate E being rigidly connected, by means of screw members, to the tubular body A and the lower plate E being located within the tube A so as to permit free expansion of tubes B. The seal is obtained by means of a packing ring O which is pressed

between the edge portion U of the lower plate E and the body A, the peripheral edge U' of the tube M, which is the outlet for the gases, also pressing against the packing O. Tube M is connected to the body A by means of screw members or other similar devices. The heat exchanger shown in Fig. 16 obviously may have the details thereof varied to adapt the same for particular uses.

The above-described structure permits the construction of a boiler of desired capacity simply by varying the number of water and fire tube elements of the invention, these latter elements being conveniently stored away. The above-described boiler has an extremely large capacity, considering the size thereof, and is easy to maintain, particularly when the inner tubes are readily accessible at both ends thereof.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of water and fire tube elements differing from the types described above.

While the invention has been illustrated and described as embodied in water and fire tubes for steam boilers, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A water and fire tube element comprising, in combination, an outer elongated tubular body formed with inlet and outlet openings adjacent opposite ends thereof, respectively; an inner tubular body located within said outer tubular body, extending in the longitudinal direction

thereof and having opposite open inlet and outlet end portions passing through the wall of said outer tubular body, said inner tubular body being at least partially formed with a plurality of annular corrugations which are spaced from each other by progressively decreasing distances in the direction from said inlet end portion to said outlet end portion of said inner tubular body.

2. A water and fire tube element comprising, in combination, an outer elongated tubular body formed with inlet and outlet openings adjacent opposite ends thereof, respectively; an inner tubular body located within said outer tubular body, extending in the longitudinal direction thereof and having opposite open inlet and outlet end portions passing through the wall of said outer tubular body, said inner tubular body being at least partially formed with a plurality of annular corrugations which are spaced from each other by progressively decreasing distances in the direction from said inlet end portion to said outlet end portion of said inner tubular body, all of said corrugations being located adjacent to said outlet end portion of said inner tubular body.

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