Jan. 24, 1933. C. E. LUCKE ET AL 1,894,957

AIR HEATER

Filed April 27, 1932

Fig. 1

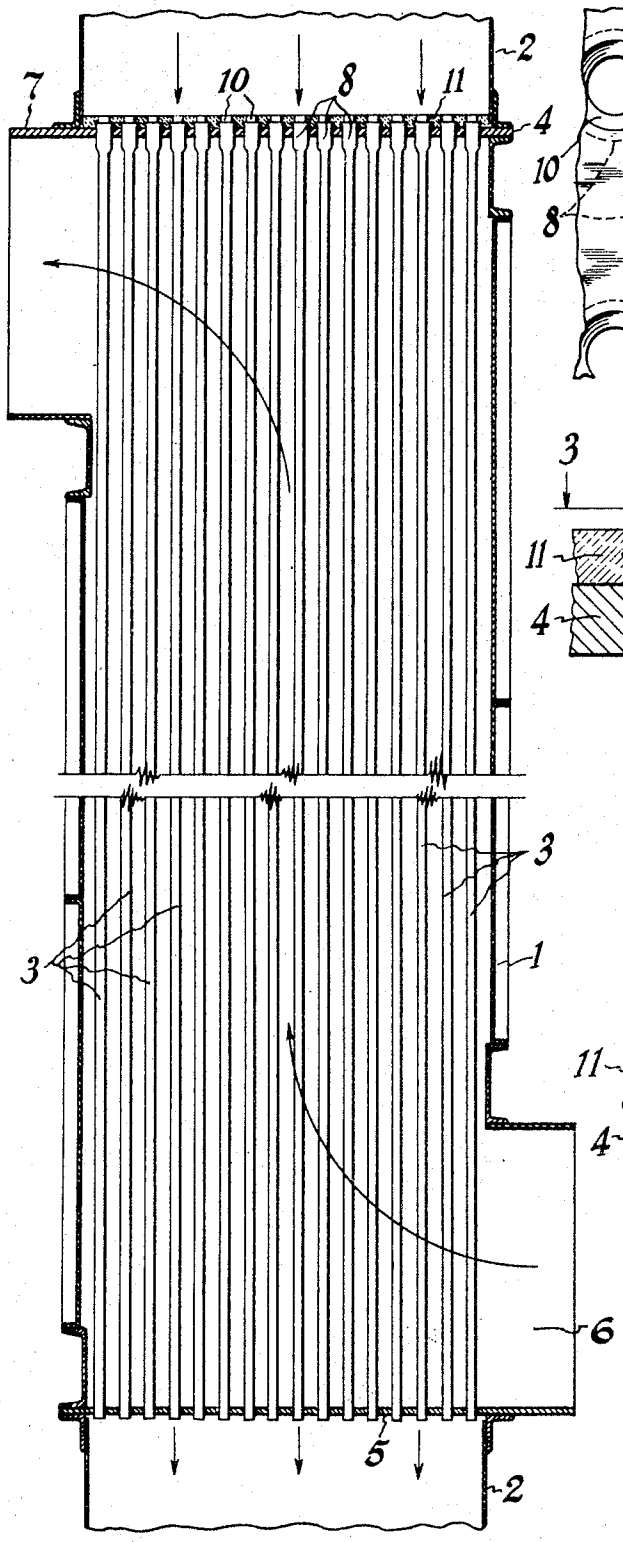


Fig. 3

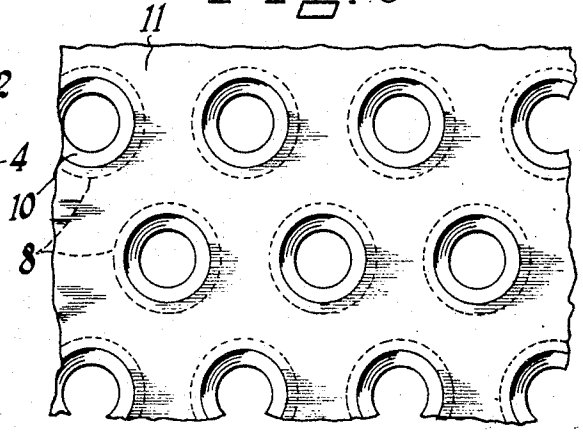


Fig. 2

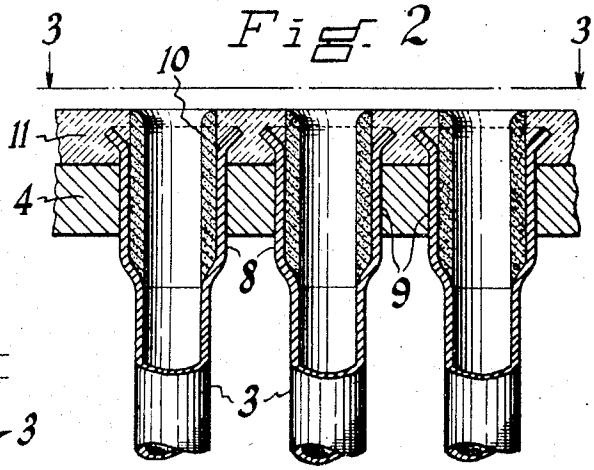
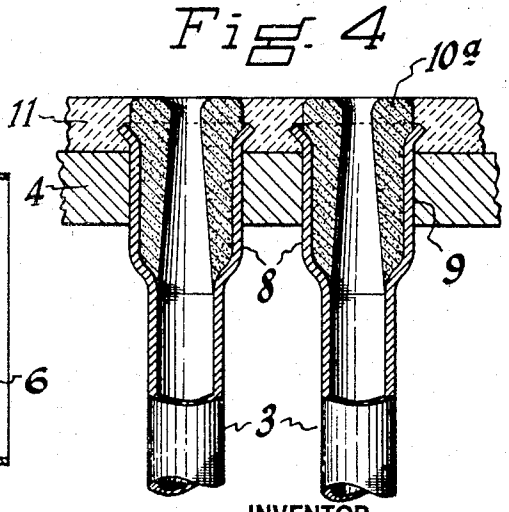


Fig. 4



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UNITED STATES PATENT OFFICE

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AIR HEATER

Application filed April 27, 1932. Serial No. 607,772.

Our present invention relates to the construction of fluid heat exchangers in which the conduits for the heating fluid are formed by tubes or plates having their ends held in position in plates arranged transversely in a casing or flue through which the heating fluid passes. Such plates being exposed to the high temperature fluid on one side tend to rapidly deteriorate in use. This effect is especially noticeable in the plate contacted with by the heating fluid before its temperature is reduced by the fluid being heated. It has heretofore been proposed to cover this plate with a layer of refractory material at its high temperature side, as disclosed in the pending application of H. J. Kerr Serial No. 333,009, filed January 16, 1929. Even when so constructed the plate will receive a substantial amount of heat by conduction through the conduit portions seated therein, which heat may be sufficient to disadvantageously affect the material of the plate.

The general object of our present invention is the provision of a fluid heat exchanger of the character described in which provisions are made for protecting the plate at the heating fluid inlet end of the heat exchanges from heat absorbed directly from the heating fluid and by conduction through the conduit portions seated therein. A further object of our invention is the provision of special refractory heat insulating members adapted to be received in the seated portions of the heating fluid conduits and characterized by their simplicity of construction, low cost of manufacture and ease of installation. Another object is the provision of refractory heat insulating members for the seated portions of the heating fluid conduits which improves the fluid flow therethrough and thereby the heat transfer between the heating fluid and the fluid to be heated.

The various features of novelty which characterize our invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawing and descriptive matter in which we have illustrated and described preferred embodiments of our invention.

In the drawing, Fig. 1 is a vertical section through an air heater constructed in accordance with our invention; Fig. 2 is a vertical section on an enlarged scale of a portion of the apparatus illustrated in Fig. 1; Fig. 3 is a plan view taken on the line 3—3 of Fig. 2; and Fig. 4 is a view similar to Fig. 2 of a modification.

The air heater illustrated in the drawing comprises a casing 1, preferably of rectangular cross-section, forming a part of a flue 2, through which is passed high temperature heating gases from a steam boiler or other apparatus from which high temperature gases are withdrawn. As indicated by the arrows in the drawing, the heating gases pass downwardly to the casing 1 through conduits formed by rows of straight tubes 3 having their opposite end portions expanded into openings 9 formed in tube plates 4 and 5, arranged at the inlet and outlet ends of the tubes, respectively. The air to be heated, such as air used for combustion purposes, enters through a side inlet 6 in the lower portion of the casing 1, and passes upwardly through the casing sweeping the tubes therein and out through a side outlet 7 arranged adjacent the tube plate 4. A countercurrent flow of the heating fluid and the fluid to be heated is thus provided.

With the heating gas flow described, it is highly desirable that the tube plate 4 be protected from excessive heat imparted thereto by the heating gases contacting with its upper surface and by conduction through the tube portions seated in the plate. As shown in Figs. 2 and 3, the upper end portions 8 of the tubes 3 are considerably enlarged and expanded into the openings 9 in the tube plate, the tube end portions being of greater internal diameter than the main portion of the tubes and projecting beyond the upper surface of the plate 4. The enlarged end portions are arranged to receive a layer of heat insulating material preferably in the form of a separate sleeve or thimble 10 having an internal diameter corresponding to the internal

diameter of the main portion of the tubes 3. The thimbles 10 are constructed to snugly fit into the end portions of the tubes, and protect the tube seats from the effects of the high temperature heating gases. The tube plate 4 is further protected by a layer of refractory heat insulating material 11, preferably applied to its upper surface in a plastic state after the thimbles 10 have been installed. The ends of the tubes 3 are preferably belled to hold the material 11 in place after it hardens. The upper surface of the material 11 is substantially flush with the upper ends of the thimbles 10, and the inlet ends of the thimble passages are enlarged to facilitate the entrance of the heating gases.

With the air heater construction described, the tube plate 4 will be adequately protected from the effects of high temperature heating gases, and the durability of the construction substantially increased. The temperature of the tube plate will be kept closer to the temperature of its inner face due to the increased resistance to the passage of heat to its outer side effected by the layer of heat insulating material and the continuous absorption of heat by the relatively cold air contacting with its inner side. The described construction is particularly useful in air heaters subject in operation to high temperature heating gases. In such a construction, by the use of the described protecting arrangement, it is possible to use a tube plate of standard material rather than one of expensive alloy or similar heat resistant material.

In Fig. 4 a construction similar to that of Fig. 2 is illustrated except that the thimbles 10*a* in Fig. 4 have a passage of Venturi form, the discharge end of the passage registering with and of substantially the same diameter as the tube internal diameter. The use of refractory thimbles with Venturi-shaped passages increases the velocity of gas flow through the tubes, and avoids the formation of low pressure areas at the inlet and of the tubes which would tend to create eddy currents. At the same time it permits of thickening the insulating thimble and strengthening it near the end where it has least support by the metal.

While in accordance with the provisions of the statutes we have illustrated and described herein the best forms of our invention now known to us, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by our claims, and that certain features of our invention may sometimes be used to advantage without a corresponding use of other features.

We claim:

1. In a fluid heat exchanger, a flue arranged for the passage of a heating fluid, a plate member extending across said flue in the path of said heating fluid and formed with a series of conduit openings therein, a plurality of conduit elements in said flue for the passage of said heating fluid and having enlarged end portions seated in the openings in said plate member and projecting beyond the outer side of said plate member, a layer of heat insulating material surrounding the projecting portions of said conduit elements and contacting with the outer side of said plate member, the projecting portions of said conduit elements being constructed to hold said material against the outer side of said plate member, heat insulating material positioned in and contacting with the enlarged end portion of each of said conduit elements forming a fluid passage registering with the passage in said conduit element, and means arranged to provide a flow of a fluid to be heated through said flue in contact with said conduit elements.

2. In a fluid heat exchanger, a flue arranged for the passage of a heating fluid, a plate member extending across said flue in the path of said heating fluid and formed with a series of tube openings therein, a plurality of tubes in said flue for the passage of said heating fluid and having enlarged end portions seated in the openings in said plate member and projecting beyond the outer side of said plate member, a layer of heat insulating material surrounding the projecting portions of said tubes and contacting with the outer side of said plate member, the projecting portions of said tubes being constructed to hold said material against the outer side of said plate member, thimbles of heat insulating material positioned in and contacting with the enlarged end portions of each of said tubes and having a passage formed therein registering with the passage in said tubes, and means arranged to provide a flow of a fluid to be heated through said flue in contact with said tubes.

3. In a fluid heat exchanger, a flue arranged for the passage of a heating fluid, a plate member extending across said flue in the path of said heating fluid and formed with a series of tube openings therein, a plurality of tubes in said flue for the passage of said heating fluid and having enlarged end portions seated in the openings in said plate member, a refractory thimble positioned in and contacting with the enlarged end portion of each of said tubes and having an internal cross-sectional area corresponding to the internal cross-sectional area of said tube, and means arranged to provide a flow of a fluid to be heated through said flue in contact with said tubes.

4. In a fluid heat exchanger, a flue arranged for the passage of a heating fluid, a plate member extending across said flue in the path of said heating fluid and formed with a series of tube openings therein, a plurality of

tubes in said flue for the passage of said heating fluid and having enlarged end portions seated in the openings in said plate member and projecting beyond the outer side of said plate member, a layer of heat insulating material surrounding the projecting portions of said tubes and contacting with the outer side of said plate member, a refractory thimble positioned in and contacting with the enlarged end portion of each of said tubes and having a Venturi-shaped passage formed therein arranged to register with the passage through said tube, and means arranged to provide a flow of a fluid to be heated through said flue in contact with said tubes.

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