

July 9, 1929.

J. W. YOUNG

1,720,536

HEAT EXCHANGER

Filed May 27, 1927

3 Sheets-Sheet 1

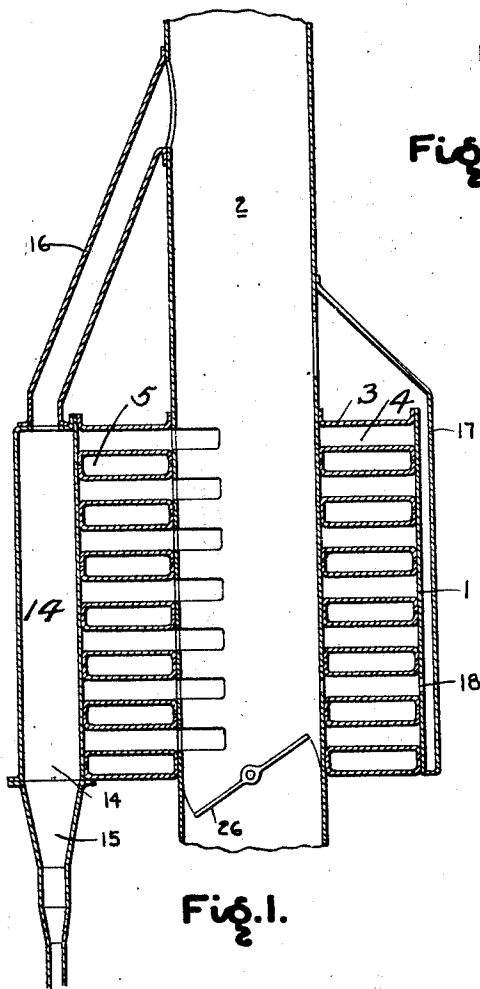


Fig. 1.

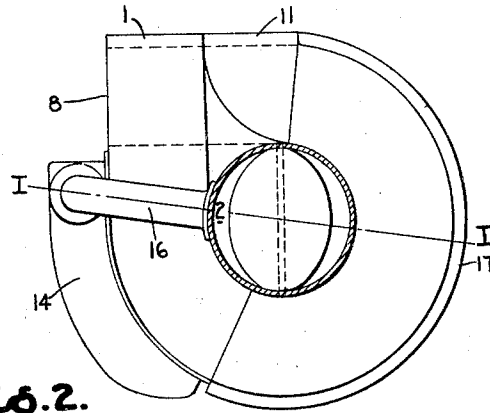


Fig. 2.

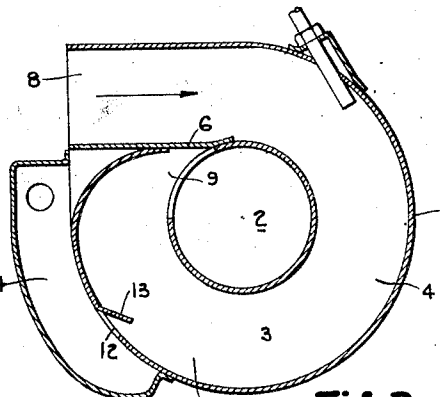


Fig. 3.

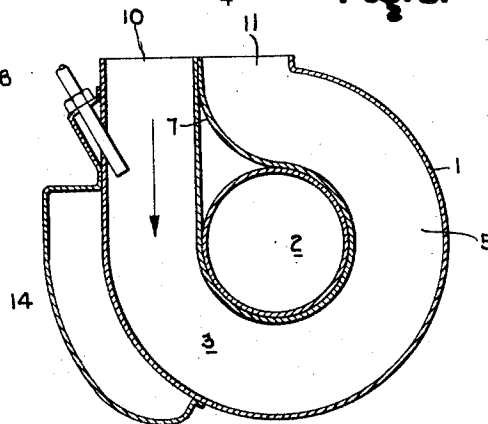


Fig. 4.

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3 Sheets-Sheet 2

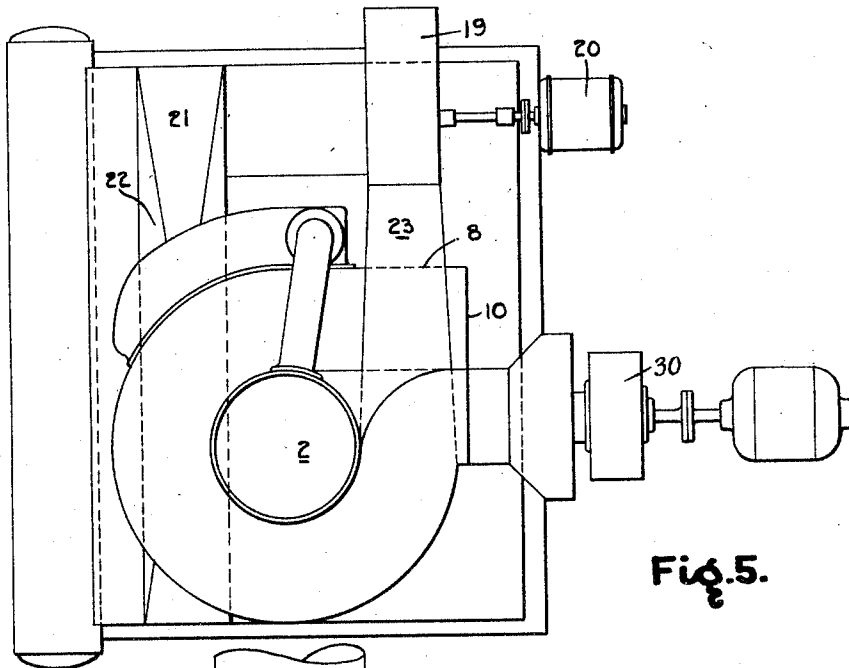


Fig. 5.

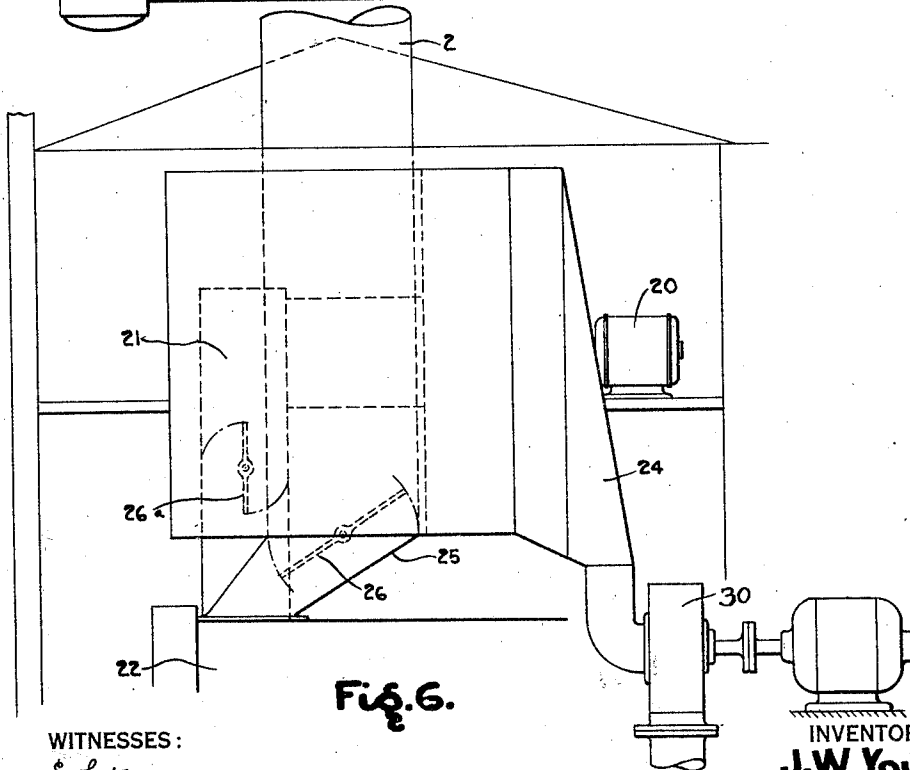


Fig. 6.

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3 Sheets-Sheet 3

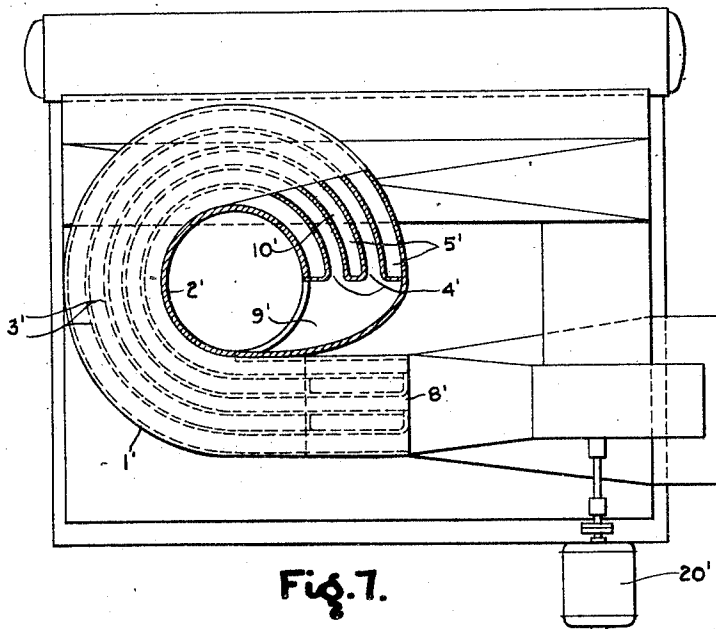


Fig. 7.

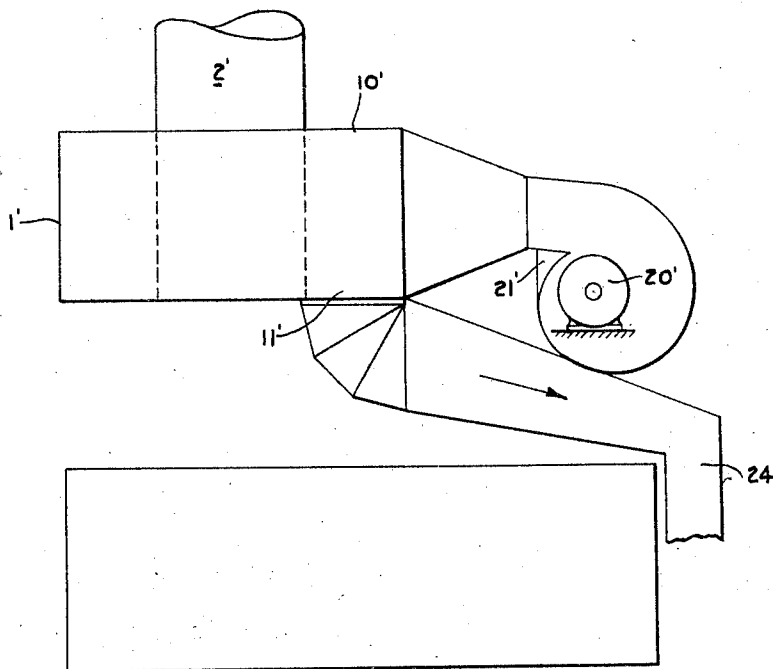


Fig. 8.

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HEAT EXCHANGER.

Application filed May 27, 1927, Serial No. 194,787, and in Great Britain June 16, 1926.

This invention relates to heat exchangers, particularly air preheaters for furnaces, and consists in apparatus of this nature comprising a series of annular or similarly shaped chambers juxtaposed one against another with provision for causing the fluids, between which the transference of heat is desired, to circulate, preferably in opposite directions, through alternate chambers.

According to one construction the heat exchanger comprises a casing of substantially cylindrical form, disposed about a furnace offtake and divided by transverse partitions into a series of chambers each of which is divided by a baffle or partition extending between the casing and the flue, one chamber of each pair of adjacent chambers communicating with the exterior of the casing adjacent one side of the baffle and with the flue adjacent the other side of the baffle, while the other of said chambers communicates with the exterior of the casing upon opposite sides of the baffle. The casing is advantageously formed with a tangential projecting portion through which the chambers communicate with the exterior of the casing, and the fluids enter adjacent chambers through inlets in said tangential portion arranged so that the fluids pass in opposite directions through adjacent chambers. Such an apparatus may be readily constructed from a number of similar sections assembled together and moreover may, if desired, be made almost entirely of sheet metal, so that the manufacture is comparatively simple.

Where the heat exchanger is intended for use with fluids which may contain suspended solid matter, as in the case of an air preheater for the air necessary for the combustion of solid or pulverulent fuel in a furnace, utilizing the heat of the flue gases leaving said furnace, means is preferably provided for separating and collecting any solid products of combustion which might be in the flue gases. Such separating device may comprise lateral openings in certain of the chambers through which the solid matter may be ejected, a collecting chamber being also provided to collect the solids and permit the escape of any gases which pass out therewith.

In a modified construction the heat exchanger comprises a casing of substantially cylindrical form disposed about the flue and divided into a series of concentric chambers by partitions which extend around the

greater part of the cylindrical portion of the casing, one chamber of each pair of adjacent chambers communicating with the flue at one end and with the exterior of the casing at the other end, and the other chamber communicating with inlet and outlet openings in the external walls of the casing.

These and further features of the invention will be more readily understood from the following description with reference to the accompanying drawings in which two constructional forms of the invention are illustrated more or less diagrammatically and wherein:

Fig. 1 is a sectional elevation corresponding to line I—I of Fig. 2, showing an air preheating and smut catching apparatus according to the invention applied to a flue or chimney;

Fig. 2 is a plan corresponding to Fig. 1;

Figs. 3 and 4 represent horizontal cross-sections through any two adjacent chambers of the pre-heater shown in Figs. 1 and 2;

Figs. 5 and 6 are a plan and side elevation respectively, showing an arrangement of boiler-house plant embodying the invention; and,

Figs. 7 and 8 are, respectively, a plan and front elevation illustrating a modified construction of heat-exchanger according to the invention arranged for preheating the air supply for the furnace of a steam generator.

Referring more particularly to Figs. 1 to 6, the air preheater shown comprises a casing 1 of substantially cylindrical form disposed about an offtake 2 and divided by a large number of transverse partitions 3, whereby a plurality of juxtaposed chambers of more or less annular form are provided. As seen from Figs. 3 and 4 which represent two adjacent chambers, 4, 5 intended for the passage of the flue gases and air blast respectively, the chambers are themselves divided by baffles or partition walls 6, 7 extending between the casing 1 and the wall of the flue 2, the chamber 4 communicating with the exterior of the casing through an inlet 8 adjacent the baffle 6 on one side and with the flue 2 through an outlet 9 adjacent the other side of the baffle, while the chamber 5 communicates with the exterior of the casing through inlet and outlet apertures 10, 11 respectively, upon opposite sides of the baffle 7.

In order to preserve, as far as possible, the stream line flow of the gases, the baffles, 6, 7

are arranged to merge tangentially with the circular walls of the casing and flue, and for the convenient attachment of the gas or air supply trunks the casing 1 is formed with a tangential projecting portion through which the chambers communicate with the exterior of the casing as is readily seen from Figs. 2 to 4. By this arrangement also the inlet and outlet openings in each chamber are as remote as possible circumferentially, and the direction of flow, which is indicated by arrows in Figs. 3 and 4, is reversed in alternate chambers so that the advantages of contra-flow of the flue gas and air are availed of.

For the purpose of removing any solid matter carried by the flue gases, the outer wall of each chamber 4 is provided with an aperture 12 somewhat in advance of the outlet 9 and adjacent said aperture is a deflecting plate 13 extending inwardly of the casing 1, and a collecting compartment 14 externally of the casing 1. The compartment 14 terminates at its lower end in a discharge hopper 15, and at the upper end communicates through a pipe 16 with the chimney or flue 2.

With this arrangement the flue gas enters the flue gas chambers and due to the furnace draught, which may be natural, induced forced, or forced and induced, is caused to pass rapidly therearound to the outlets communicating with the flue. Owing to the speed with which the flue gas traverses the gas chambers any solid suspended matter therein is thrown against the outer wall of the chambers and is deflected by the plates 13 through the apertures 12 therein to the collecting compartment from which it is either fed directly back to the furnace or removed periodically for this purpose. Any flue gas passing out with the solid products of combustion expands into the collecting compartment 14 where its velocity is reduced and from which it passes back through pipe 16 to the offtake 2.

If desired a jacket 17 may be provided around the outside of casing 1, said jacket serving for the passage of air or flue gas and communicating with some or all of the chambers 4 or not, as may be preferred. In Fig. 1 it is shown independent of the chambers 4 and merely constitutes an offtake gas jacket communicating with the flue 2 at the top and through a passage 18 near the bottom.

In the above description it is assumed that the apparatus is located around a vertical part of the offtake so that the apparatus as a whole is vertical and the compartments horizontal. This however is not essential as the apparatus as a whole may be horizontal or inclined according to practical requirements. In the above construction the inner wall of the apparatus is constituted by an existing part of a furnace offtake and the outer wall is in one part with the various inlet and outlet branches formed therein as may be most

convenient for practical purposes, by cutting the wall and bending back portions thereof, by the addition of suitable walls or passages, or by a combination of these expedients. The apparatus may however be sectionalized, that is to say, each air and gas compartment may constitute a complete integer, in which case such compartment or sections may be standardized and an apparatus of any desired capacity built up by merely associating a suitable number of compartments or sections. The apparatus may thus be readily taken apart for repair or for cleaning purposes if desired; where the construction is not sectionalized however, steam jets may be advantageously employed for this latter purpose.

Figs. 5 and 6 illustrate the above described apparatus erected in the upper part of a boiler-house around the bottom of an offtake 2. An induced draught fan 19 driven by a motor 20 is adapted to draw the flue gases from the boiler furnace through the uptake 21 of an economizer 22 and to force them through a flue gas supply trunk 23 attached to the inlet 8 of the preheating apparatus, around the chambers 4 of which they pass to the offtake 2 as previously described. At the same time, air is drawn through the inlet 10, which is open to the atmosphere, around the chambers 5 where it is heated and is drawn out through the air trunk 24 by means of a forced draught fan 30 of the boiler furnace. Naturally, in some cases, the fans may be dispensed with, the circulation being effected by the natural draught. A by-pass 25 provided with a damper 26 is also provided between the economizer 22 and the flue 2, and a similar damper 26^a or other regulating device may if desired be provided in the uptake 21, whereby the flow of the flue gases through the preheating apparatus or directly to the chimney 2 may be controlled.

In the modified form of the apparatus shown in Figs. 7 and 8, a casing 1' of substantially cylindrical form is arranged around a flue or chimney 2' and divided into series of concentric chambers by partitions indicated by dotted lines 3' which extend around the greater part of the cylindrical portion of the casing from an annular branch or extension, but terminate somewhat short of the junction of the annular and tangential portions of the casing. Alternate chambers 5' are closed at each end, and the remaining chambers 4' communicate at one end with an inlet 8' associated with a boiler or economizer uptake 21' with or without an induced draught fan driven by a motor 20', and at the other end with the undivided portion of the casing which communicates directly with the flue 2' through an outlet 9'. By this arrangement it will be apparent that the hot gases leaving the furnace will be caused to travel along alternate compartments to the undivided por-

tion of the casing and from thence to the chimney or flue.

The chambers 5' which are closed at each end communicate through an inlet 10' near the undivided portion of the casing with the free atmosphere, and, near the end of the tangential portion communicate through an outlet 11' with the air supply trunk 24' of the furnace or, if a forced draught fan is employed, with the suction of such fan, as shown in Fig. 6, by which arrangement it will be apparent that air for combustion will be caused to travel around the casing in alternate chambers and in an opposite direction to that taken by the flue gases, extracting heat from the latter during its passage.

While I have shown my invention in two forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In a heat exchanger, the combination of a circular shaped casing; a plurality of annular plates disposed within the casing and forming therewith a series of transversely-extending, juxtaposed annular chambers; means providing for the flow of a heating fluid through alternate ones of said chambers; and means providing for the flow of fluid to be heated through the remaining ones of said chambers, and in a direction contra to that of the heating fluid.

2. In an air preheater, the combination of a circular shaped casing; a plurality of annular plates disposed within the casing and forming therewith a series of transversely-extending, juxtaposed annular chambers; means providing for the flow of flue gases through alternate ones of said chambers; and means providing for the flow of air to be heated through the remaining ones of said chambers, and in a direction contra to that of the flue gases.

3. In an air preheater, the combination of a circular shaped casing; a plurality of annular plates disposed within the casing and forming therewith a series of transversely-extending, juxtaposed annular chambers; means providing for the flow of flue gases through alternate ones of said chambers; and means providing for the flow of air to be heated through the remaining ones of said chambers, and in a direction contra to that of the flue gases; and means providing for the separation of the solid products of combustion from the flue gas as it flows through the chambers.

4. In a heat exchanger, the combination of a fluid conduit; a circular casing surrounding said conduit; a plurality of annular plates

disposed within the casing and forming in conjunction with the casing and conduit a series of transversely-extending, juxtaposed annular chambers; alternate ones of said chambers being provided with transversely-extending baffle members; means providing communication between said alternate chambers and said conduit at one side of said baffle members; and means providing communication between said alternate chambers and the exterior of said casing at the other side of said baffle members; baffle means arranged within the remaining ones of said annular chambers and providing a separate inlet and outlet for each one of the said remaining chambers; means providing for the transmission of a fluid through said alternate chambers; and means providing for the transmission of a second fluid through said remaining chambers; the temperature of said second fluid prior to its admission to the chambers, being different from that of the first named fluid.

5. In a heat exchanger, the combination of a fluid conduit; a circular casing surrounding said conduit; a plurality of annular plates disposed within the casing and forming its conjunction with the casing and conduit a series of transversely-extending, juxtaposed annular chambers; alternate ones of said chambers being provided with transversely-extending baffle members; means providing communication between said alternate chambers and said conduit at one side of said baffle members; and means providing communication between said alternate chambers and the exterior of said casing at the other side of said baffle members; baffle means arranged within the remaining ones of said annular chambers and providing a separate inlet and outlet for each one of the said remaining chambers; and means providing for the transmission of a second fluid through said remaining chambers, and in a direction contra to the flow of the first mentioned fluid; the temperature of said second fluid prior to its admission into the chambers, being different from that of the first fluid.

6. In an air preheater, the combination of a fluid conduit; a circular shaped casing surrounding said conduit; a plurality of annular plates disposed within the casing and forming with the casing and conduit a series of transversely-extending, juxtaposed annular chambers; alternate ones of said chambers forming a set, and being provided with transversely-extending baffle members; means providing communication between said alternate chambers and said fluid conduit at one side of said baffle members; and means providing communication between said alternate chambers and the exterior of said casing at the other side of said baffle members; the remaining ones of said chambers forming a second set, and being provided with transversely ex-

tending baffle means; means providing inlet and outlet openings at opposite sides of the baffle means in each one of the second set of annular chambers; means providing for the flow of flue gas through one set of said chambers; and means providing for the flow of air to be heated through the other set of said chambers and in a direction contra to the flow of flue gas.

7. In an air preheater, the combination of a fluid conduit; a circular shaped casing surrounding said conduit; a plurality of annular plates disposed within the casing and forming with the casing and conduit a series of transversely-extending, juxtaposed annular chambers; alternate ones of said chambers forming a set, and being provided with transversely-extending baffle members; means providing communication between said set of alternate chambers and said fluid conduit at one side of said baffle members; and means providing communication between said alternate chambers and the exterior of said casing at the other side of said baffle members; the remaining ones of said chambers forming a second set, and being provided with transversely-extending baffle means; means providing inlet and outlet openings at opposite sides of the baffle means in each one of the second set of annular chambers; means providing for the flow of flue gas through one set of said chambers; means providing for the flow of air to be heated through the other set of said chambers and in a direction contra to the flow of flue gas; and means providing for the separation of the solid products of combustion from the flue gas as it flows through the annular chambers.

8. In an air preheater, the combination of a fluid conduit; a circular shaped casing surrounding said conduit; a plurality of annular plates disposed within the casing and forming with the casing and conduit a series of transversely-extending, juxtaposed annular chambers; alternate ones of said chambers forming a set, and being provided with transversely-extending baffle members; means providing communication between said alternate chambers and said fluid conduit at one side of said baffle members; and means providing communication between said alternate chambers and the exterior of said casing at the other side of said baffle members; the remaining ones of said chambers forming a second set, and being provided with transversely-extending baffle means; means providing inlet and outlet openings at opposite sides of the baffle means in each one of the second set of annular chambers; means providing for the flow of flue gas through one set of said chambers; means providing for the flow of air to be heated through the other set of said chambers and in a direction contra to the flow of flue gas; and means disposed at the periphery of each one of the set of annular cham-

bers through which the flue gas flows, and providing for the separation of the solid products of combustion from the flue gas.

9. In an air preheater, the combination of a fluid conduit; a circular shaped casing surrounding said conduit; a plurality of annular plates disposed within the casing and forming with the casing and conduit a series of transversely-extending juxtaposed annular chambers; alternate ones of said chambers forming a set, and being provided with transversely-extending baffle members; means providing communication between said alternate chambers and said fluid conduit at one side of said baffle members; and means providing communication between said alternate chambers and the exterior of said casing at the other side of said baffle members; the remaining ones of said chambers forming a second set, and being provided with transversely-extending baffle means; means providing inlet and outlet openings at opposite sides of the baffle means in each one of the second set of annular chambers; means providing for the flow of flue gas through one set of said chambers; means providing for the flow of air to be heated through the other set of said chambers and in a direction contra to the flow of flue gas; and means for varying the amount of flue gas flowing through said chambers.

10. In an air preheater, the combination with an offtake for the flue gases from a furnace; of a circular casing surrounding said offtake; a plurality of annular plates disposed within said casing and forming with the casing and offtake a series of transversely-extending, juxtaposed annular chambers; alternate ones of said chambers being provided with transversely-extending baffle members; means providing communication between said alternate chambers and the offtake at one side of said baffle members; and means providing for the introduction of flue gas into said alternate chambers at the opposite side of said baffle members; baffle means extending transversely of the remaining annular chambers; and means providing air inlet and outlet means in the remaining chambers at opposite sides of said baffle means.

11. In an air preheater, the combination with an offtake for the flue gases from a furnace; of a circular casing surrounding said offtake; a plurality of annular plates disposed within said casing and forming with the casing and offtake a series of transversely-extending, juxtaposed annular chambers; alternate ones of said chambers being provided with transversely-extending baffle members; means providing communication between said alternate chambers and the offtake at one side of said baffles; and means providing for the introduction of flue gas into said alternate chambers at the opposite side of said baffle members; baffle means extending transversely of the remaining annular

chambers; means providing air inlet and outlet means in the remaining chambers at opposite sides of said baffle means; and means disposed at the periphery of said alternate chambers and providing for the separation of the solid products of combustion from the flue gas.

12. In an air preheater, the combination with an offtake for the flue gases from a furnace; of a circular casing surrounding said offtake; a plurality of annular plates disposed within said casing and forming with the casing and offtake a series of transversely-extending, juxtaposed annular chambers; alternate ones of said chambers being provided with transversely-extending baffle members;

means providing communication between said alternate chambers and the offtake at one side of said baffles; and means providing for the introduction of flue gas into said alternate chambers at the opposite side of said baffle members; baffle means extending transversely of the remaining annular chambers; means providing air inlet and outlet means in the remaining chambers at opposite sides of said baffle means; and means for varying the amount of flue gas flowing through said chambers.

In testimony whereof, I have hereunto subscribed my name this tenth day of May, 1927.

JOHN WILLIAM YOUNG.