July 6, 1943. G. W. THOMPSON 2,323,498

HEATING OF FLUIDS

Filed June 16, 1941 2 Sheets-Sheet 1

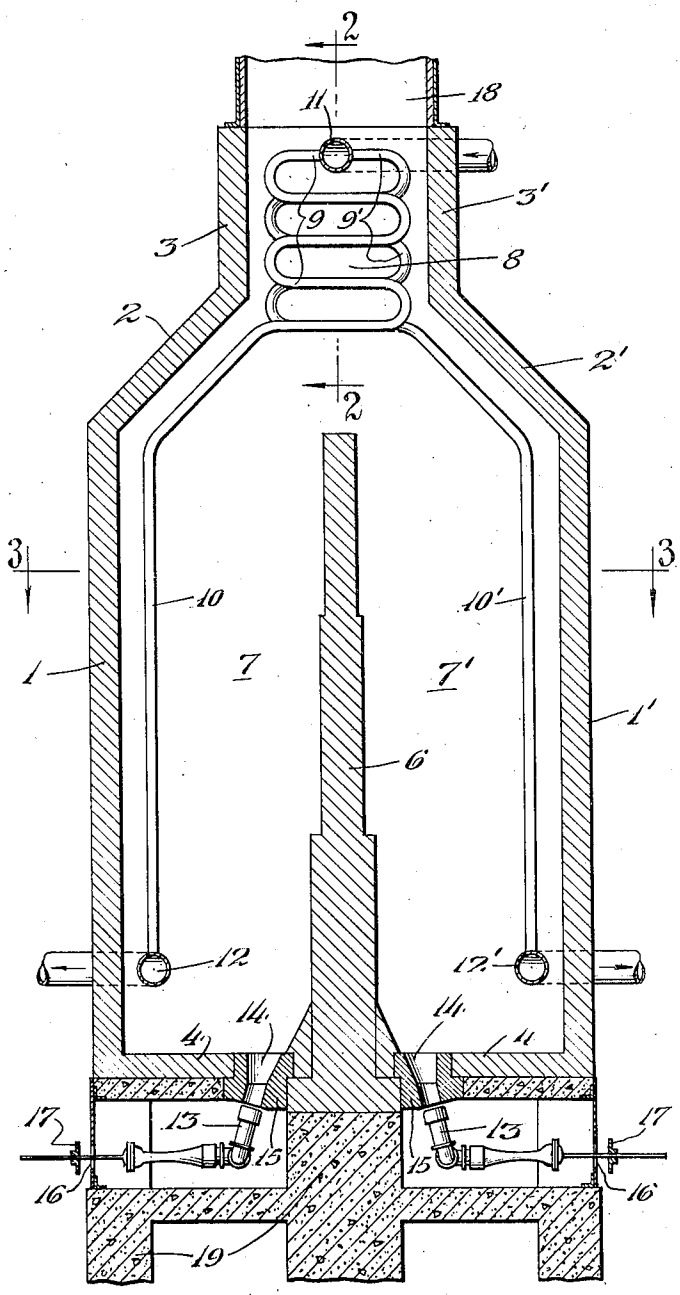


Fig. 1.

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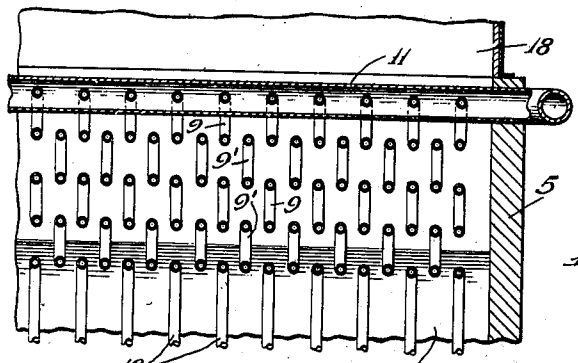


Fig. 2.

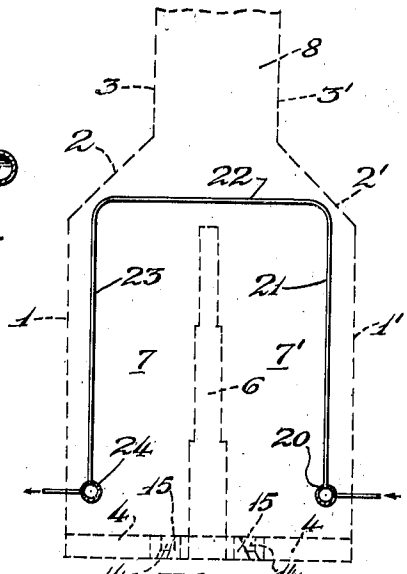


Fig. 4.

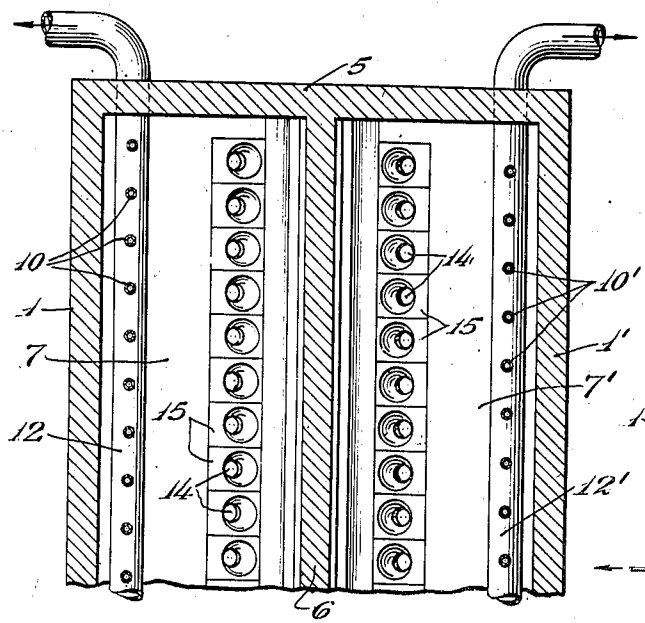


Fig. 3.

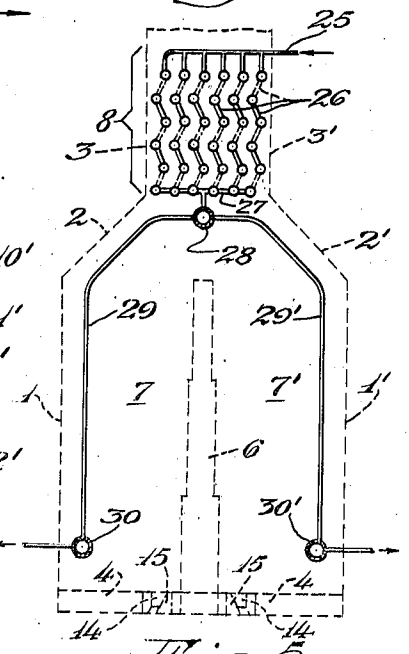


Fig. 5.

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UNITED STATES PATENT OFFICE

2,323,498

HEATING OF FLUIDS

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Application June 16, 1941, Serial No. 398,188

6 Claims. (Cl. 122—356)

This invention relates to the heating of fluids and more particularly to a heater in which separate streams of fluid, either in liquid, vaporous or gaseous state, or mixed phase, may be quickly heated to the required temperature, undergoing at the same time only a relatively small pressure drop. The features of the invention are particularly advantageous as applied to heating flue gases for use in reactivating catalyst in catalytic conversion processes but may also be used advantageously in the treatment of many other sorts of fluids and are therefore not limited to the heating of any particular type of fluid.

The heater herein disclosed is a combination radiation and convection heater of the general type known in the art as the "Center Wall Up-Draft" heater. This type of heater is disclosed in the United States Patent 2,147,662 issued to Lev A. Mekler, February 21, 1939. The heater herein provided differs principally from that disclosed in the Mekler patent in the arrangement of fluid conduits and the flow of fluid therethrough. It retains many of the advantages of the center wall up-draft heater disclosed in said patent but, due to the modified arrangement of the fluid conduit and modified flow therethrough, it functions in a different manner to provide an improved heater for use in heating gases, vapors or liquids at low cost and with low pressure drop through the heater.

Pressure drop is an important item in the design of heaters for the class of service contemplated by the invention and by using this invention a considerable reduction in pressure drop results over that suffered through the use of conventional heaters now employed for such purposes. In processes wherein pumps or blowers are required to force the fluids to be treated through the heater, the size of such equipment and the cost of installation as well as operation and maintenance is directly dependent upon the resistence encountered by the fluids in transversing the heater. Previous heaters of the general type herein provided are restricted as to the possible number of fluid streams being heated and are therefore limited as to the minimum pressure drop through the fluid conduit. However, when using the heater disclosed in this invention, the number of parallel fluid streams is dependent only upon the length of the heater.

As an example of the benefits which may be derived from the use of this invention, a comparison is here made between a conventional heater and one designed as herein disclosed. With the conventional heater design for processing 115,000 pounds per hour of reactivating gas the lowest pressure drop that could be had was calculated to be about 35 pounds per square inch. With the apparatus herein disclosed a pressure drop of only about 5 pounds per square inch is obtainable.

To further differentiate between the heater disclosed in the aforementioned patent and that herein disclosed and to reveal further advantages to be gained by the use of the latter, the accompanying diagrammatic drawings illustrating various embodiments of the invention will be described.

Fig. 1 of the drawings is a sectional elevation of a preferred form of heater embodying the features of the invention.

Fig. 2 shows a section through a portion of the heating coil of Fig. 1, this view being taken along line 2—2 in Fig. 1.

Fig. 3 represents a plan view of a portion of the heater shown in Fig. 1, this view being taken along line 3—3 in Fig. 1.

Figs. 4 and 5 each diagrammatically illustrate an alternate fluid conduit arrangement which may be employed, within the scope of this invention, in a furnace structure of the general form shown in Fig. 1. In Figs. 4 and 5 the outline of the furnace structure is shown by dotted lines.

Referring now to Figs. 1, 2 and 3, the vertical side walls of the heater are indicated by the reference numerals 1 and 1'. These walls in conjunction with the sloping walls 2 and 2', the end walls 5 (see Figs. 2 and 3) and the floor 4 substantially enclose the radiant heating zones 7 and 7' which are disposed on opposite sides of the vertical central wall 6. The vertical walls 3 and 3' and the end walls 5 similarly enclose a fluid heating zone 8. The side walls, end walls, floor, and dividing central wall are preferably constructed of a suitable refractory material, either in built up block form or of poured monolithic construction. The entire furnace structure rests upon a suitable foundation 19.

In the fluid heating zone 8, a plurality of substantially parallel U-shaped fluid conduits 9 and 9' are disposed which communicate, respectively, with a plurality of substantially vertical, parallel conduits 10 and 10' in the respective radiant heating zones 7 and 7'. The inlet manifold 11 communicates with each of the individual fluid conduits 9 and 9' and is centrally disposed in the upper portion of the fluid heating zone. The outlet manifolds 12 and 12' communicate, respectively, with the fluid conduits 10 and 10'.

It is entirely within the scope of this invention to reverse the flow through the heater, which is shown by the arrows, that is, introduce the fluids to be heated into the manifolds 12 and 12' instead of the manifold 11 and remove the heated fluid through the manifold 11 instead of from manifolds 12 and 12'. The manifolds 12 and 12' may also be connected together at their ends to provide a single header (in addition to manifold 11) which may serve either as an inlet or outlet conduit, depending upon the desired direction of flow through the heating conduits. It is also within the scope of the invention to dispose any or all of the manifolds or headers outside of the heating zones.

Combustible fuel and air are supplied to the heater by the burners 13 through the firing ports 14 in burner blocks 15 which are located in floor 4. The desired amount of excess air may be admitted to the heater through the ports 16 and regulated by means of the plates 17. Although gas burners are shown in the drawings, it is entirely within the scope of this invention to employ oil burners or suitable burners adapted to burn any other desired fuel or combination of fuels. The flames emanating from the burners 13 impinge angularly against the center wall 6, heating it to a highly radiant condition. Heat is supplied to conduits 10 and 10' by direct radiation from wall 6 and from the flames and hot combustion gases passing thereover. The partially cooled combustion gases from zones 7 and 7' pass upward through zone 8 and supply fluid heat to conduits 9 and 9' by direct contact therewith. The combustion gases are then conveyed to a suitable stack, not shown, through flue 18.

Although, when employed in the type of service for which the heater illustrated is designed, there will ordinarily be no necessity for cleaning the tube banks of the heater. Cleaning may be facilitated, when necessary, by providing holes and removable cover plates in the various manifolds and by using return bend fittings in place of the U-shaped bends illustrated in the drawings.

Fig. 4 illustrates, in outline, a heater similar to that shown in Figs. 1, 2 and 3 but with a modified fluid conduit arrangement. In this particular heater the fluid to be treated is introduced into inlet manifold 20 from which it is divided into a plurality of small streams flowing consecutively through the vertical side wall tubes 21, similar to tubes 10' of Figs. 1 and 3, then through the horizontal connecting tubes 22 and thence through the vertical side wall tubes 23, which are similar to tubes 10 of Figs. 1 and 3, the heated fluid being discharged from outlet manifold 24. In this arrangement the heating takes place substantially within the radiant zone of the heater leaving the convection zone free for use as a preheater or as a steam boiler or for any other purpose desired. With this modified conduit arrangement, it is easily possible to regulate the heat input to the tubes in combustion zones 7 and 7' by varying the combustibles supplied to the heater through burner ports 14 on opposite sides of wall 6.

In Fig. 5 is shown another form of conduit arrangement. In this case the fluid to be treated is introduced to the heater through the inlet header 25 which communicates with a plurality of U-shaped conduits 26 which are disposed lengthwise of and substantially within the fluid heating zone 8. The conduits 26 are also in communication with the header 27 which is in turn connected to the manifold 28. The latter is connected with two banks of a plurality of substantially vertical parallel tubes 29 and 29' disposed on opposite sides of wall 6 in zones 7 and 7', respectively. The heated streams of fluid from tubes 29 and 29' are respectively collected by the manifolds 30 and 30' for transference from the heater to any other processing or treating equipment desired.

One feature of that embodiment of the invention shown in Fig. 5 is that, as the fluid undergoing treatment in the heater absorbs heat and expands, allowance is made for this increase in volume by using a greater number of fluid streams or larger fluid conduits in the hotter portion of the furnace than are employed in the initial heating zone (i. e., the tube banks comprising tubes 29 and 29' are each greater in internal cross-section than the tube bank comprising tubes 26).

I claim as my invention:

1. In a heater for fluids having separate combustion and heating zones defined by refractory walls, substantially vertical side walls and a substantially vertical dividing wall disposed centrally therebetween, means for impinging flames and hot combustion gases against the surface of one of said walls in each combustion zone and for directing the same thereover in a substantially vertical direction, a fluid heating zone above said vertical dividing wall to and through which combustion gases from the separate combustion zones are supplied, a bank of substantially vertical tubular fluid conduits disposed adjacent the surface of the unfired wall in each of the separate combustion zones, and a bank of substantially horizontal tubular fluid conduits disposed within the fluid heating zone, the tubes of each of said banks being connected for the flow of separate streams of fluid therethrough in parallel and the tube banks in the combustion zones being connected in series with the tube bank in the fluid heating zone.

2. A heater for fluids comprising, in combination, side and end walls defining the lower portion of a furnace, a central wall dividing said lower portion of the furnace into separate combustion zones, a fluid heating zone of smaller cross-sectional area than said lower portion of the furnace disposed above said central wall and communicating with each of said combustion zones, a tube bank comprising fluid conduits arranged for the parallel flow of separate streams of fluid therethrough disposed in the fluid heating zone, substantially vertical tubular fluid conduits disposed in each of the combustion zones adjacent said side walls and opposite the central wall, the last named tube banks being connected in parallel with each other and in series with the first named tube bank, and means adjacent said central wall for directing combustible fuel air mixtures upwardly at an angle against opposite faces of the central wall.

3. A heater for fluids comprising, in combination, side and end walls defining the lower portion of a furnace, a central wall dividing said lower portion of the furnace into separate combustion zones, a fluid heating zone of smaller cross-sectional area than said lower portion of the furnace disposed above said central wall and communicating with each of said combustion zones, a fluid conduit comprising a plurality of tubular elements arranged for the flow of sepa-

rate streams of fluid therethrough in parallel disposed within the fluid heating zone, a manifold and means connecting said tubular elements with the manifold, a bank of substantially vertical tubular fluid conduits disposed adjacent said side wall in one of the combustion zones and terminating at their upper ends in said manifold, another bank of substantially vertical tubular fluid conduits disposed adjacent said side wall in the other combustion zone and terminating at their upper ends in said manifold, the tubular elements of each of the banks in the combustion zone being connected at their lower ends with a separate manifold.

4. A heater for fluids comprising, in combination, side and end walls defining the lower portion of a furnace, a central wall dividing said lower portion of the furnace into separate combustion zones, a fluid heating zone of smaller cross-sectional area than said lower portion of the furnace disposed above said central wall and communicating with each of said combustion zones, separate tube banks disposed in said fluid heating zone to be substantially uniformly heated by the combustion gases passing through the latter, a separate tube bank adjacent each of said side walls in the fluid heating zones, the tubular elements of the last named bank being substantially vertically disposed, the tubular elements of each bank being connected for the flow of separate streams of fluid therethrough in parallel, one of the tube banks in the fluid heating zone being connected in series with the tube bank in one of the combustion zones and the other tube bank in the fluid heating zone being connected in series with the tube bank in the other combustion zone.

5. A heater for fluids comprising a furnace structure having a lower portion and an upper portion, a vertical wall dividing said lower portion into a pair of combustion zones, a manifold in said upper portion of the furnace structure above said wall, means for firing the combustion zones and for passing combustion gases from both said zones through said upper portion of the furnace structure, a bank of substantially vertical tubular elements in each of the combustion zones and a plurality of fluid conduits, each comprising serially connected tubes, in said upper portion of the furnace structure, the tubular elements of each of said banks and said fluid conduits being in communication with said manifold.

6. A heater for fluids comprising a furnace structure having a lower portion and an upper portion, a vertical wall dividing said lower portion into a pair of combustion zones, a manifold in said upper portion of the furnace structure above said wall, means for firing the combustion zones and for passing combustion gases from both said zones through said upper portion of the furnace structure, a bank of substantially vertical tubular elements in each of the combustion zones and a plurality of fluid conduits, each comprising serially connected tubes, in said upper portion of the furnace structure, each of said vertical tubular elements being connected to one of said fluid conduits and said fluid conduits being connected to said manifold.

GEORGE W. THOMPSON.