March 17, 1942. J. W. THROCKMORTON ET AL 2,276,529

FURNACE CONSTRUCTION

Filed July 9, 1941 2 Sheets-Sheet 1

Fig. 1.

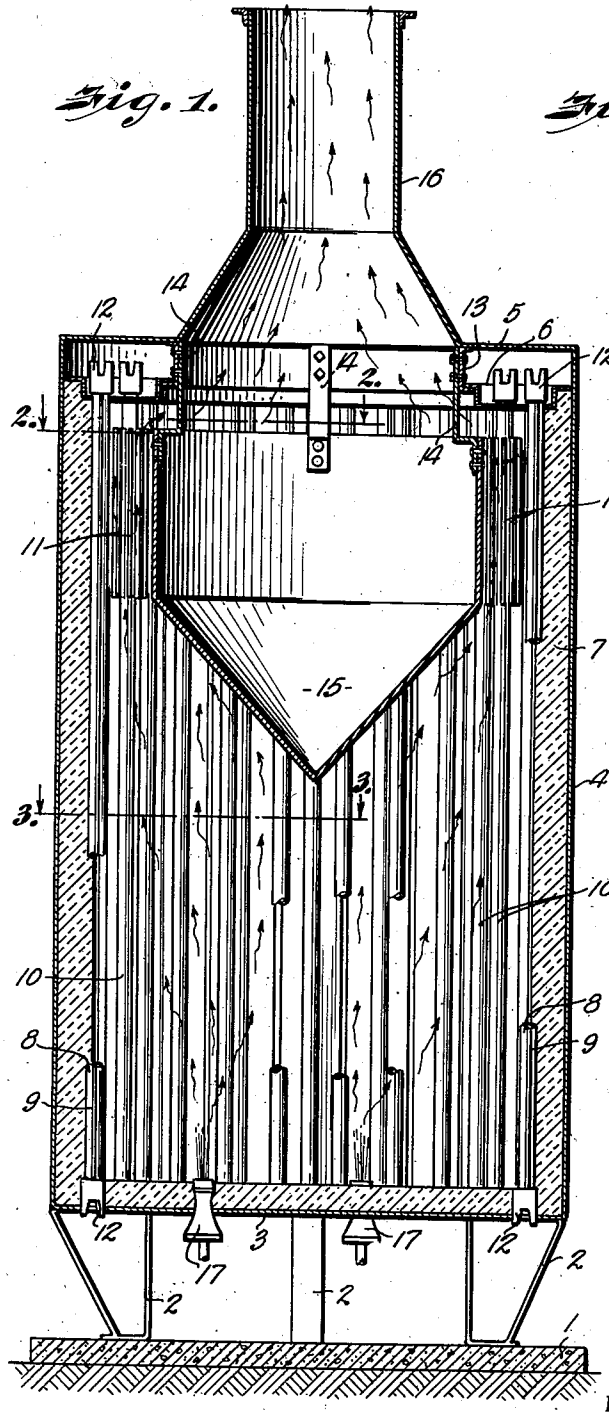


Fig. 2.

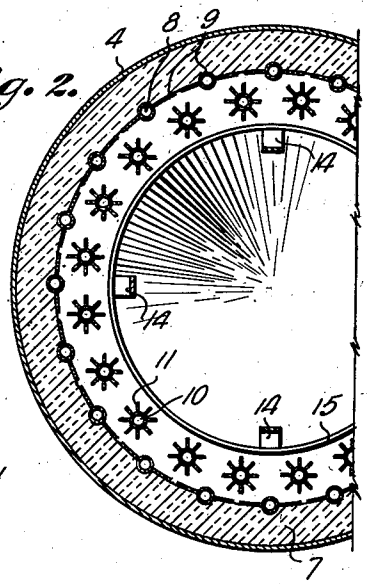
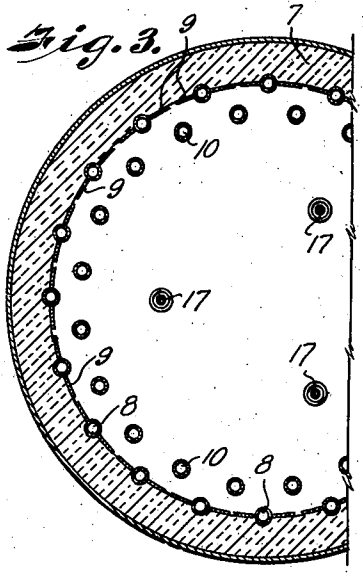


Fig. 3.



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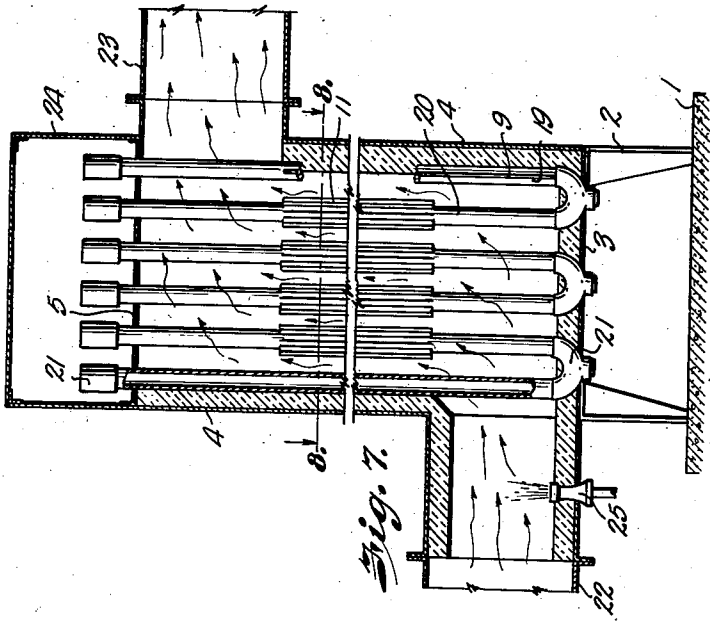


Fig. 7.

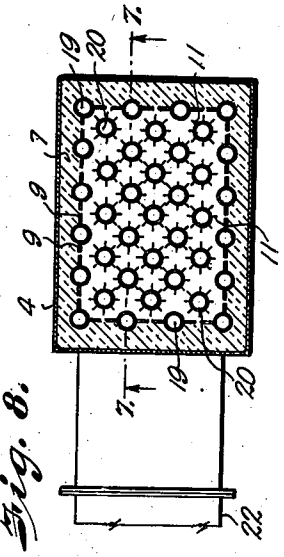


Fig. 8.

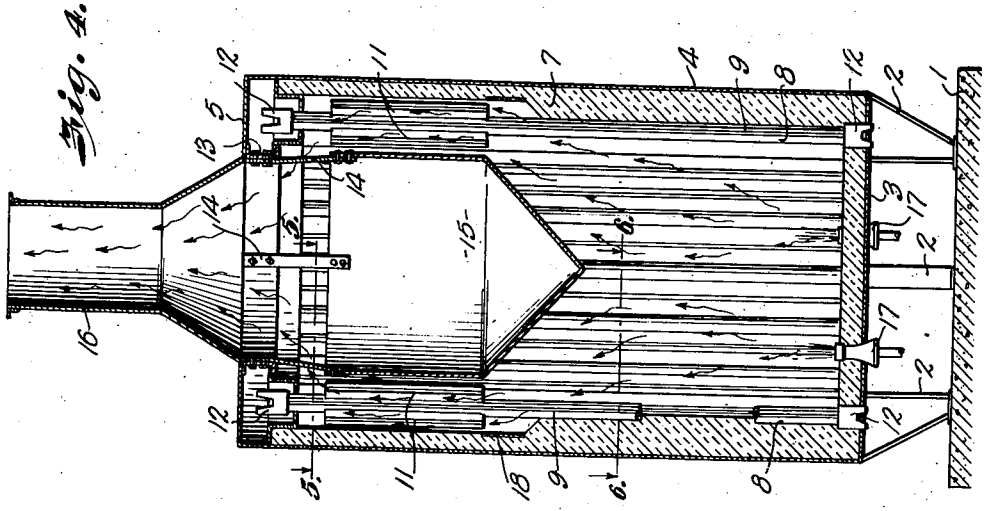


Fig. 4.

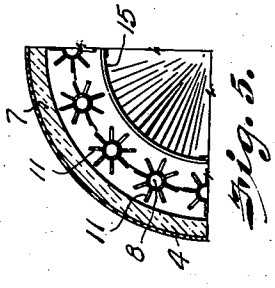


Fig. 5.

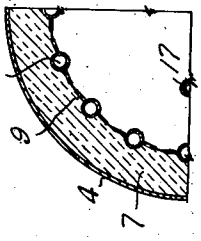


Fig. 6.

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UNITED STATES PATENT OFFICE

2,276,529

FURNACE CONSTRUCTION

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Application July 9, 1941, Serial No. 401,594

5 Claims. (Cl. 122—356)

This invention relates to improvements in furnace construction and refers more particularly to a vertical tube furnace substantially circular in cross section, in which the heating elements or tubes are arranged in concentric circles around the interior wall surface of the furnace, the outer tube bank or circle of tubes adjacent or in close proximity to the wall having extended surfaces or fins arranged to support the insulating or refractory material constituting the interior of the furnace and exposing increased heat absorption surfaces; the inner circle of tubes constituting the inner tube bank and receiving the main heating duty, serving to partially shield the outer bank from excessive radiant heat.

In order to more uniformly distribute the heat along the surfaces of the inner bank, it is contemplated that extended surfaces or fins may be used in the convection section of the furnace and bare or plain surfaced tubes in the radiant section.

Heating gases are supplied to the furnace by properly positioned burners arranged to distribute the heat uniformly within the furnace. In the upper part of the furnace is positioned a cone for reflecting the radiant heat toward the tubes in the radiant section and deflecting the gases to flow over the tube surfaces in the convection section or cooler portion of the furnace.

An advantage of the design lies in its simplicity and efficiency, the cost of construction being reduced by the manner in which the tubes are supported and the reduction in the amount of structural steel necessary to support the furnace walls.

A further object of the invention is to make a furnace boiler or economizer using various combinations of bare and fin tubes, while maintaining at all times a light weight furnace setting or enclosing wall structure.

By means of this design, it is possible to have a completely prefabricated, shop assembled furnace with the setting, wall structure and heating elements of light weight construction.

In design, the course of the gas flow and arrangement of heat exchange elements is such that an optimum condition is provided for the exhaustion of heat from the combustion gases.

In the accompanying drawings which form part of the instant specification and are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views;

Fig. 1 is a vertical section of one type of furnace design according to the invention.

Fig. 2 is a horizontal section taken along the line 2—2 in Fig. 1.

Fig. 3 is a horizontal section taken along the line 3—3 in Fig. 1.

Fig. 4 is a slightly modified type of construction in which the wall insulation is reduced somewhat in the convection section.

Fig. 5 is a fragmentary view taken along the line 5—5 in Fig. 4.

Fig. 6 is a fragmentary view taken along the line 6—6 in Fig. 4.

Fig. 7 is a modified design taken along the line 7—7 in Fig. 8 and showing the invention as applied to an economizer installed in the flue gas passageway or breeching.

Fig. 8 is a sectional view taken along the line 8—8 in Fig. 7.

Referring to the drawings, on a base 1 and supporting the furnace from below are pedestals 2. Upon the pedestals is a steel plate furnace casing, comprising a bottom 3, side wall 4 and a top 5. Within the casing 4 and supported from the top by means of a channel 6 are banks of heating tubes arranged in concentric circles around the inner surface of the furnace. Surrounded by the furnace casing is a wall of insulating or refractory material shown at 7. The outer circle or bank of tubes 8 have fins or extended surfaces 9, shaped to conform with the inner cylindrical surface of the insulating or refractory material, both the tubes and the fins serving to support the insulating or refractory material from within, the outer casing 4 supporting the insulating or refractory material on the outside. The inner circle of tubes or inner tube bank 10 are plain surfaced tubes within the radiant section or that portion of the furnace subjected to radiant heat, while the upper portions of the tubes 10 within the convection section of the furnace or that portion receiving principally convection heat have extended surfaces or fins 11 extending radially from the surface of the tubes. The particular type of fins or extended surfaces utilized is of no importance, the advantages contemplated being the use of the fins on the outer bank to support the insulating or refractory wall and the fins on the inner bank offering increased absorption surface for the inner bank of tubes in the convection section where the combustion gases are at reduced temperature. The vertical tubes 8 and 10 are equipped with a conventional type of return bends and removable plugs 12 at top and bottom, to facilitate cleaning.

Attached to the top plate 5 is a circular sup-

port 13 upon which the inner flange of the channel 6 rests. This support 13 also carries the hangers 14 which support the deflecting cone 15. On top of the furnace setting is a chimney or flue 16. Extending through apertures in the refractory material, forming the bottom of the furnace are burners 17 located to distribute the heating gases uniformly throughout the combustion space.

The passage of the heating gases is shown by the arrows in Fig. 1, Fig. 4 and Fig. 7. In Figs. 1 and 2 the gases pass upwardly through the radiant section, either in a linear flow or in a spiral course according to the angle at which the burners are positioned.

In the lower portion of the furnace where the firing takes place, the exposed surfaces of the tubes are subjected principally to radiant heat. The inner circle or inner bank of tubes are preferably staggered with the outer bank, thereby distributing the radiant heat more uniformly over the exposed surfaces of the separate tube banks. A sufficiently high heat transfer rate is obtained in this zone to warrant the exposure of plain tubes for the inner tube bank, while fins or extended surfaces are used in the outer bank, due to the fact that the outside half of the tube surfaces is embedded and insulated from the heat in the insulating material. As previously suggested, the extended surface elements, or fins, on the outer bank not only offer increased heat absorption surfaces but also support the insulating or refractory material which forms the inner wall of the furnace. In its passage upward through the furnace, the gas is diverted near the upper portion of the radiant section by the cone 15. This inverted cone has a cylindrical upper portion which forms a restricted annular space or channel, between the outer periphery of the cylindrical portion of the cone and the furnace wall. The combustion gas, diverted by the cone, flows through this restricted channel or annular passageway in its travel from the radiant section of the furnace to the flue 16. This restricted channel or annular passageway is, for convenience, designated as the convection section of the furnace as the portions of the tubes positioned therein receive principally convection heat. This convection section is distinguished from that portion of the furnace below the cone 15, designated as the radiant section, wherein the tubes receive principally radiant heat.

Although not indicated in the drawings, sections of the top part of the furnace casings 5 are removable in order that plugs 12 may be removed from the tubes for cleaning or the vertical tubes of either bank taken from the furnace in case replacement or repair is necessary.

In the modification shown in Fig. 4, the convection section is surrounded by insulating or refractory material of considerably less thickness than that surrounding the radiant section. This is feasible as the temperature of the heat exchange fluid or combustion gas passing over the surfaces of the fin covered tubes is considerably lower than the temperature of the gases of combustion in the radiant section of the furnace. This reduction of the thickness of the insulating or refractory wall permits an increase in the depth of the fins and the amount of extended or heat exchange surface that can be added to the tubes in the convection section. In this type of construction where the fins 9 of the outer tube bank do not serve as a support for the insulating or refractory material in the convection section of the furnace, a supplementary cylindrical sheet 18, conforming in shape with the inner surface of the furnace, may be required to hold the insulating or refractory material in this section of the furnace in place. The economizer shown in Figs. 7 and 8, preferably interposed in the furnace flue or passageway through which heating gases are discharged, adopts the principal features of the vertical tube furnace shown in Figs. 1 and 4. This structure includes a base 1, upon which stand pedestals 2. The pedestals support the base plate 3 and enclosing sides of the metallic casing 4. The heat exchange elements in the economizer have a plurality of vertical tubes including a wall bank 19 and internally positioned tubes 20. The wall bank 19 is partially embedded in the insulating or refractory material 7 and, together with the fins or extended surfaces 9, support the insulating or refractory wall between the tubes and the casing 4. The lower and upper ends of the tubes may be connected by means of return bends 21, as shown in Fig. 7 or by headers of any suitable type, in order to obtain the desired fluid flow therethrough. The inlet and outlet connections to the tube bank will be arranged according to the desired method of flowing the fluid through the tubes. These connections have been purposely omitted from the drawings in the interests of simplicity, as the method of coursing the fluids through the tubes in either the economizer or the furnace forms no part of the instant invention, except that it is important that the fluid be distributed in its passage through the tubes in a manner to obtain the most efficient and economical heating.

The flue gas passing through the economizer is admitted through the pipe 22, flows in the direction shown by the arrows through the heating section of the economizer and out through the discharge pipe 23. In the lower and upper portions of the economizer, adjacent the inlet and outlet ports, where the combustion gas travels across the tube surfaces and more nearly at a right angle to the axes of the tubes, plain or bare surfaced tubes are used. In the mid-section of the economizer or intermediate the inlet and discharge ports where the heating gas flows relatively parallel to the tubes, extended or fin surfaces 11 are employed. This arrangement serves to distribute the heat absorption surface more uniformly through the length of the tubes, while the fins on the tube bank adjacent the insulating or refractory wall serve not only as a support but also add a heat absorption surface which is lost to the tubes by partially embedding them in the wall of the economizer.

Over the upper ends of the tubes is a removable cover 24 which may be taken off for cleaning, replacement, or repair of the tubes. In the inlet pipe 22 may be positioned a burner 25 to augment the heat of the gases passing through the economizer.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of our claims. It is further obvious that various changes may be made in details within the scope of our claims without departing from the spirit of our invention. It is, therefore, to be understood that our invention is not to be limited to the specific details shown and described.

Having thus described our invention, we claim:

1. A furnace construction of the character described including an enclosing wall structure of insulating or refractory material substantially circular in cross section, a plurality of banks of vertical tubes arranged adjacent the inner wall surface in concentric circles, extended surface elements on the tube bank in close proximity to the wall supporting the insulating or refractory wall and exposing increased heat absorption surface, a source of combustion gas within the tube banks and an outlet flue in the top of the furnace.

2. A furnace construction of the character described including an enclosing wall structure of insulating or refractory material substantially circular in cross section having radiant and convection sections, two banks of vertical tubes arranged adjacent the inner wall surface in concentric circles, extended surface elements on the tubes in close proximity to the wall supporting the insulating or refractory material and exposing increased heat absorption surface, an inner tube bank assuming the main heating duty and shielding the outer tube bank from excessive radiant heat, a source of combustion gas within the tube banks and an outlet flue in the top of the furnace.

3. A furnace construction of the character described including an enclosing wall structure of insulating or refractory material substantially circular in cross section and having radiant and convection sections, a plurality of banks of vertical tubes arranged adjacent the inner wall surface in concentric circles, extended surface elements on the outer tube bank in close proximity to the wall supporting the insulating or refractory material and exposing increased heat absorption surface, an inner tube bank having plain surfaces in the radiant section and extended surfaces in the convection section of the furnace, a source of combustion gas within the tube banks and an outlet flue in the top of the furnace.

4. A heater construction of the character described, including an enclosing wall structure of insulating or refractory material, vertical tubes adjacent the insulating or refractory walls and partially embedded therein, extended surface elements on the wall tubes assisting the wall tubes in supporting the insulating or refractory material, a bank of vertical tubes within the wall tube bank, a depending deflector member having a lower conical portion forming a convection zone, extended surface elements on the inner tube bank exposing increased heat absorption surfaces in said convection zone, a combustion gas supply, an inlet for introducting said gas to the heater, and an outlet for discharging spent gas therefrom.

5. A furnace construction of the character described including an enclosing wall structure of insulating or refractory material having radiant and convection sections, two banks of vertical tubes arranged adjacent the inner wall surface in concentric banks, extended surface elements on the outer tube bank in close proximity to the wall supporting the insulating or refractory material and exposing increased heat absorption surface, an inner tube bank assuming the main heating duty and shielding the outer tube bank from excessive radiant heat, extended surface on the inner tube bank in the convection zone, a source of combustion gas within the tube banks and an outlet flue in the top of the furnace.

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