

Sept. 5, 1933.

G. W. BATCHELL

1,925,711

RECUPERATOR

Filed May 29, 1931

3 Sheets-Sheet 1

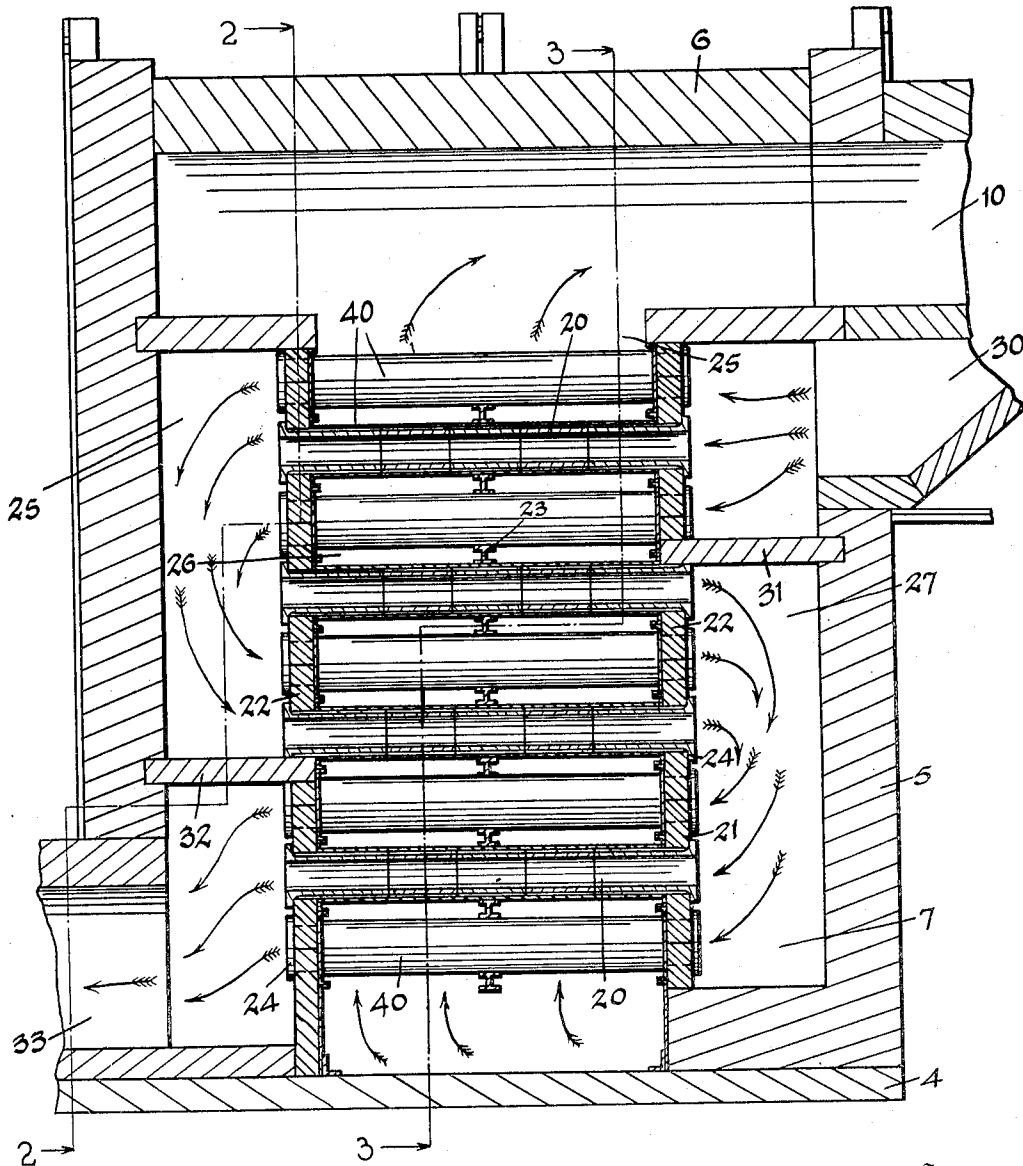


Fig 1

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3 Sheets-Sheet 2

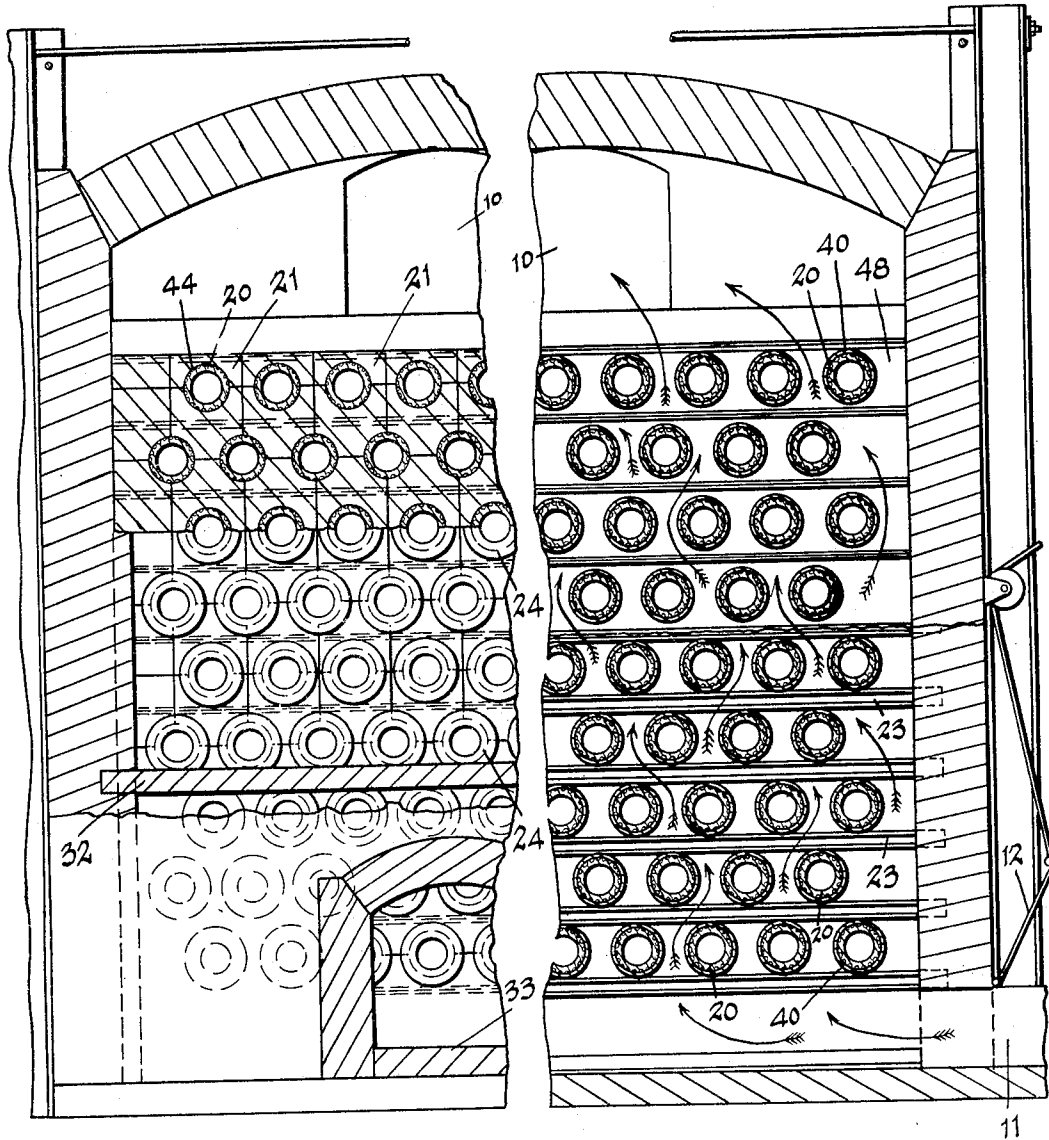


Fig 2

Fig 3

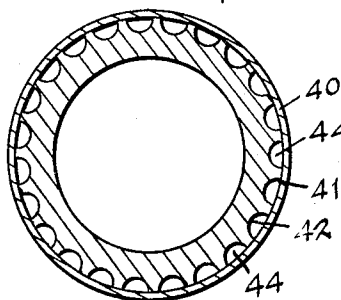


Fig 4

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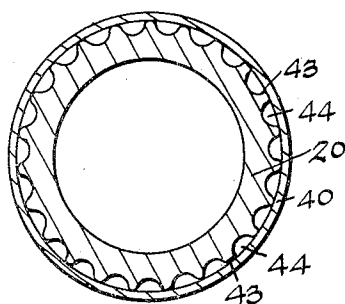
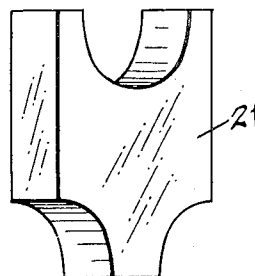
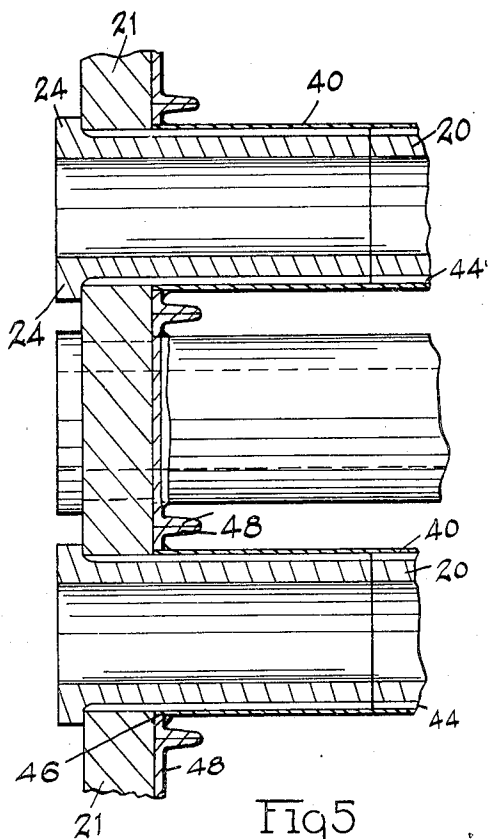
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RECUPERATOR

Filed May 29, 1931

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

1,925,711

RECUPERATOR

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7 Claims. (Cl. 263—20)

This invention relates to recuperator constructions for furnaces. It particularly relates to a recuperator construction for the pre-heating of gases preparatory to their ignition within the firing chamber of the furnace. The invention provides a means for conveying exhaust gases from the firing chamber of the furnace through units interspersed in the chamber through which fresh gases are directed towards the firing chamber to heat the fresh gases preparatory to ignition. The invention also provides units which are heat insulated to prevent the rapid transmission of heat from the exhaust gases, as they are first received from the firing chamber, to the exterior of the units and thereby provides a means for maintaining the exhaust gases in all the units at a high degree of heat which gradually diminishes as the exhaust gases near the outlet of the units, effecting thereby a rapid raising of the temperature in a large volume of fresh gas as it is moved through a relatively small chamber toward the firing chamber of the furnace. The invention also provides means for sealing the units from the chamber in which the fresh gases are moved to prevent the mixing of the exhaust gases with the fresh gases and thereby permits of the use of a pressure means to move the gases through the units or the chambers. The invention further provides a means for preventing explosions from taking place by reason of mixing the heated exhaust gases with the fresh gases whereby spontaneous ignition and combustion might occur.

Another object of my invention is to provide means for protecting the sealing parts about the units from deterioration or transfiguration by the extreme temperatures of the exhaust gases.

A further object of my invention is to provide units for pre-heating gases which are supported on fitted blocks and which may easily be removed for adjustment or replacement of the units.

The invention consists in other features and advantages which will appear from the following description and upon examination of the drawings. Structures containing the invention may partake of different forms and may be varied in their details and still embody the invention. To illustrate a practical application of the invention I have selected a recuperator embodying the invention as an example of the various structures and details thereof that contain the invention and shall describe it hereinafter, it being understood that variations may be used without a corresponding use of other features and without departing from the spirit of the invention. The

particular structure selected is shown in the accompanying drawings.

Fig. 1 of the accompanying drawings illustrates a view of a cross-section of the recuperator construction. Fig. 2 illustrates a view of a section taken on the plane of the line 2—2 indicated in Fig. 1. Fig. 3 illustrates a view of a section taken on the plane of the line 3—3 indicated in Fig. 1. Fig. 4 illustrates a cross-sectional view of one of the heating units of the recuperator. Fig. 5 illustrates an enlarged view of a portion of the units. Fig. 6 illustrates a perspective view of one of the supporting blocks for the heating units. Fig. 7 illustrates a cross-section of a modified form of the heating units.

The recuperator illustrated in the accompanying drawings is particularly provided for furnaces in which it is desirable and necessary to maintain high temperatures, such as a glass furnace, and consequently in which large quantities of fuel gases and vapors are burned to maintain such temperatures. It has been found, as is well known, that to heat the gases preparatory to their ignition results in a more efficient and complete oxidation of the gases and the obtaining of higher calorific values in such oxidation. Therefore, to so treat the gases by pre-heating, the cost of maintaining high temperature, and consequent operation of the furnace, will be reduced. Heretofore, regenerator constructions have been provided in which the gases are pre-heated by being passed through a chamber containing checkerwork which has been previously heated by passing hot exhaust gases through the chamber and in contact with the checkerwork. Such chambers have been, and are, commonly built below the ground surface level and require large space and expenditure of money to install. They have proven not only cumbersome, but inefficient in raising the temperature of the fuel gases previous to ignition and require alternate operation of heating and cooling. Under the present day circumstances of rapid and steady operation, the fuel gases cannot be permitted to remain a sufficient length of time within the chamber of the well known regenerator to raise the temperatures of gases to an efficient degree. Therefore, I have provided a plurality of units through which exhaust gases are conducted and located within a chamber through which fresh gases are conducted to the burner. The fresh gases in moving through the chamber take up the heat of the exhaust gases by transmission through the walls of the units. The units may be formed of refractory materials, such as fired clay, to prevent ero-

sion by the high temperature and volatile material of the exhaust gases. The units may be surrounded by suitable metal jackets or shells which seal the units and prevent the escape of exhaust gases through the clay parts which may become cracked by reason of the heat distortion. Thus, the hot exhaust gases may be directed from the firing portion of the furnace through a plurality of such units to heat the fresh gases moving through the air chamber in contact with the units.

In order to retard the transmission of heat and to protect the shells or jackets from melting and fusion, by reason of the heat, the clay parts of the units may be corrugated so that contact with the metal jackets or shells is reduced to a small area and the jackets suitably held in spaced relation to the clay parts, thereby forming a plurality of insulating chambers between the clay parts and the jacket in which may be located a low conductant of heat, such as air. Consequently, there will be a reduced temperature gradient between the various units as the exhaust gases progress from one unit to another and a consequent high temperature gradient between the fresh gases as they are introduced into the air chamber and delivered to the burner and the firing chamber of the furnace. This feature permits the use of a small heating chamber for fresh gases and rapid utilization of such fresh gases in operation of the furnace.

The recuperator shown for purposes of illustration is supported on a suitable floor 4 and has walls 5 which are covered by a roof 6 to form a recuperator chamber 7. The chamber 7 is connected preferably to a mixing chamber of a furnace by such a passage-way as the passage-way 10. A gas, such as air, may be introduced into the chamber 7 through a vent 11 located in the lower part of the wall 5. The vent 11 is preferably controlled by a damper 12. The air may be moved through the chamber 7 to the passage-way 10 leading to the mixing chamber of a furnace.

In order to heat the air as it moves through the chamber 7 to raise the temperature preparatory to the introduction of the air to the burner of a furnace, a plurality of heat exchange units 20 may be located throughout the chamber 7. The units 20 are preferably tubular in shape and are formed of refractory material, such as fire clay. The units 20 are supported by V-shaped blocks 21 which are adapted to fit about the units 20 and form walls 22. The blocks 21 not only support the units 20, but also space them in staggered relationship to each other in order to baffle the movement of air through the chamber 7 about the units. The units 20 are provided with flanges 24 which may be formed integrally with the units and are adapted to extend over the blocks 21, engaging the blocks and substantially sealing the points of connection between the blocks and the units. Suitable I beams 23 are supported in the walls 5 and cooperate with the walls 22 of blocks 21 to support the units 20 within the chamber 7.

The walls 22 formed of blocks 21, divide the chamber 7 into a series of separate compartments 25, 26 and 27. The exhaust gases are collected and directed from the firing portion of a furnace and are introduced into the compartment 27 by a passage-way 30. A baffle 31 may be located in the compartment 27 which sub-divides the compartment and directs the exhaust gases from the compartment 27 through the units 20 connecting the compartment 27 to the compart-

ment 25. The compartment 25 may also be provided with a baffle 32 which directs the exhaust gases through other of the units 20 back to the compartment 27. A suitable conduit 33 is preferably connected to lower portions of the compartment 25 below the baffle 32 to draw the exhaust gases back through still other of the units 20 and out through the conduit 33. Thus, the exhaust gases will be drawn through successive groups of units 20 to heat the units 20 and the air which may be moved through the compartment 26. As the gases progress from the uppermost units to the lower-most units, the temperature of the exhaust gases will gradually decrease as the heat is transmitted to the air in the compartment 26.

In order to prevent the air which may be moved in the compartment 26 from becoming mixed with the exhaust gases which may escape through cracks or lesions formed in the units 20 caused by heat distortion, the units 20 are surrounded by metal jackets 40. The jackets 40 may be formed of chromium alloy steel or any suitable metal having high heat resistant qualities. The units 20 may have corrugated surfaces 41 formed as by fluting the exterior surface of the units, as shown at 42 in Fig. 4, or may have, as in the modified form shown in Fig. 7, a continuous sinuous corrugated surface 43.

The surfaces 41 or 43 are located in contact with, and hold the jackets 40 in a spaced relationship with the units 20 and form a plurality of chambers 44 about the units 20 and between the jackets 40 and the units. The chambers 44 may be filled with a substantial non-conductant, such as air. Thus, the exterior surfaces of the jackets 40 will be substantially heat insulated from the units 20 and will transmit to the air moving through the compartment 26 only such heat as is conveyed through the small areas of the parts of the corrugated surface of the units that contact with the jackets, and the lesser transmission of heat by radiation from the fire clay to the metal tubes that is conducted through the air in the corrugations or the chambers between the ridges of the fluted tube. As the exhaust gases move through successive groups of units 20 the heat will be gradually transmitted to the air within the compartment 26.

In order to seal the ends of the jackets 40 and to provide an interior metallic veneer or covering to the walls 22 of the blocks 21 to prevent mixture of the exhaust gases and the air, the jackets 40 may be secured as by welding in openings 46 formed in channel plates 48. The channel plates 48 preferably extend the length of the recuperator chamber 7 and coact with one another to support the ends of the jackets 40 in position within the compartment 26 and seal the walls 22.

Thus, the exhaust gases will be conveyed from the furnace to the stack through passage-ways and chambers having refractory walls highly resistant to the heat of the exhaust gases and the fresh gases will be conveyed through chambers having sealed metallic veneer walls substantially heat insulated from the exhaust gases to the firing portions of the furnace.

The recuperator may be easily disassembled by removing the blocks and channel plates 48 for repair or adjustment of the parts within the recuperator. The parts may be reassembled by replacing the parts as they were removed for disassembly.

I claim:

1. In a recuperator heat exchange unit, a tubular clay body having corrugated exterior surfaces, a metallic jacket located about the clay body, means for directing heated gases through the clay body, and means intermediate the clay body and the metallic jacket resistant to the transmission of heat of the gases from the clay body to the exterior surface of the jacket.

2. In a recuperator, a chamber, a plurality of refractory bodies having metallic jackets, a plurality of Y-shaped blocks forming walls for supporting the refractory bodies in staggered relationship within the chamber, a plurality of channel plates having openings to receive the metallic jackets and adapted to seal the walls.

3. In a recuperator, a chamber having an inlet and an outlet, the outlet connected to a furnace, the inlet having a damper for controlling the inlet, a plurality of hollow refractory bodies located in the chamber, a plurality of metal jackets located about the refractory bodies, a plurality of Y-shaped blocks forming walls for supporting the clay bodies in staggered relationship in the chamber, a plurality of channel plates coacting to form a veneer wall contiguous to the block wall, the channel plates having openings for supporting the metal jackets, means for directing exhaust gases from the furnace through the refractory bodies to heat the gas within the chamber for causing movement of the gas toward the furnace.

4. In a recuperator, a passageway, a chamber connected to the passageway, a plurality of heat exchange units extending through the chamber, each of the heat exchange units comprising a pair of concentric tubes, one of the tubes located within the other and having longitudinal peripheral ridges for engaging the other tube and forming a plurality of substantially sealed chambers located about the said inner tube for resisting heat transmission from the interior of the heat exchange units to the first named chamber.

5. In a recuperator for a furnace, the recuperator having an inlet and an outlet, a plurality of intercommunicating tubular heat exchange units located between the inlet and the outlet, means for directing hot exhaust gases from the furnace through the heat exchange units proximate to the outlet and progressively therefrom to the units proximate to the inlet, the heat exchange units having means for resisting the transmission of heat whereby the heat transmitted by the heat exchange units proximate to the outlet will be substantially of the same degree as that transmitted by the heat exchange units at the inlet.

6. In a recuperator for a furnace, the recuperator having an inlet and an outlet, a plurality of intercommunicating heat exchange units located between the inlet and the outlet, means for directing hot exhaust gases from the furnace through the heat exchange units, each of the heat exchange units comprising a pair of concentric tubes, one of the tubes located within the other and having longitudinal peripheral ridges for engaging the other tube, and forming a plurality of sealed chambers between the tubes resistant to the transmission of heat whereby the heat transmitted by all the heat exchange units will be substantially of the same equal degree in any of the units between the inlet and the outlet.

7. In a recuperator for a furnace, a passageway for directing fuel gas to the furnace, a chamber connected to the passageway, a heat exchange unit located in the chamber comprising a tubular clay body having corrugated exterior surfaces, means for directing the exhaust gases from the furnace through the tubular clay body, a metal jacket located about the clay body and forming chambers resistant to heat transmission between the clay body and the jacket.

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