

Sept. 13, 1932.

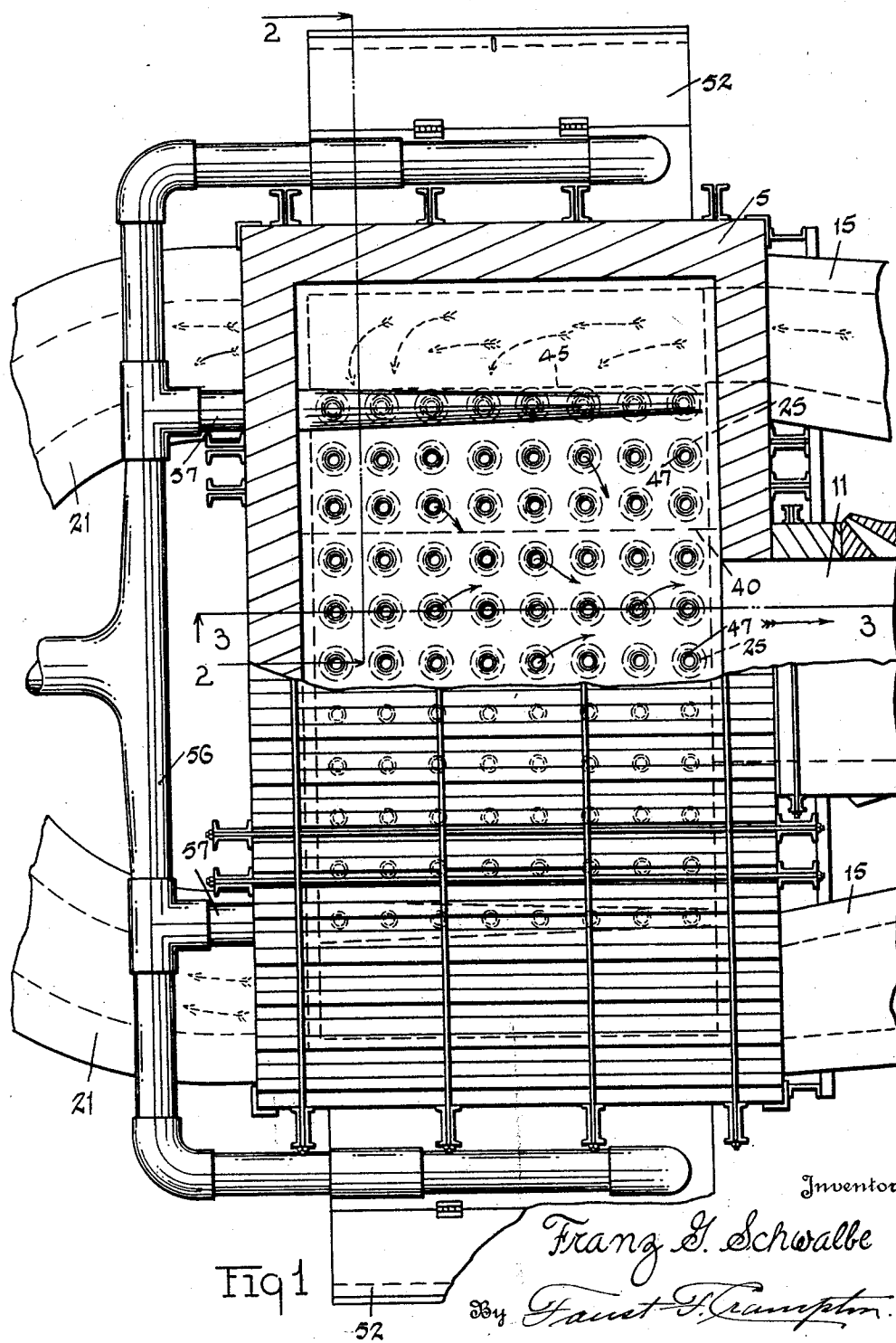
F. G. SCHWALBE

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RECUPERATOR CONSTRUCTION

Filed Jan. 10, 1931

4 Sheets-Sheet 1



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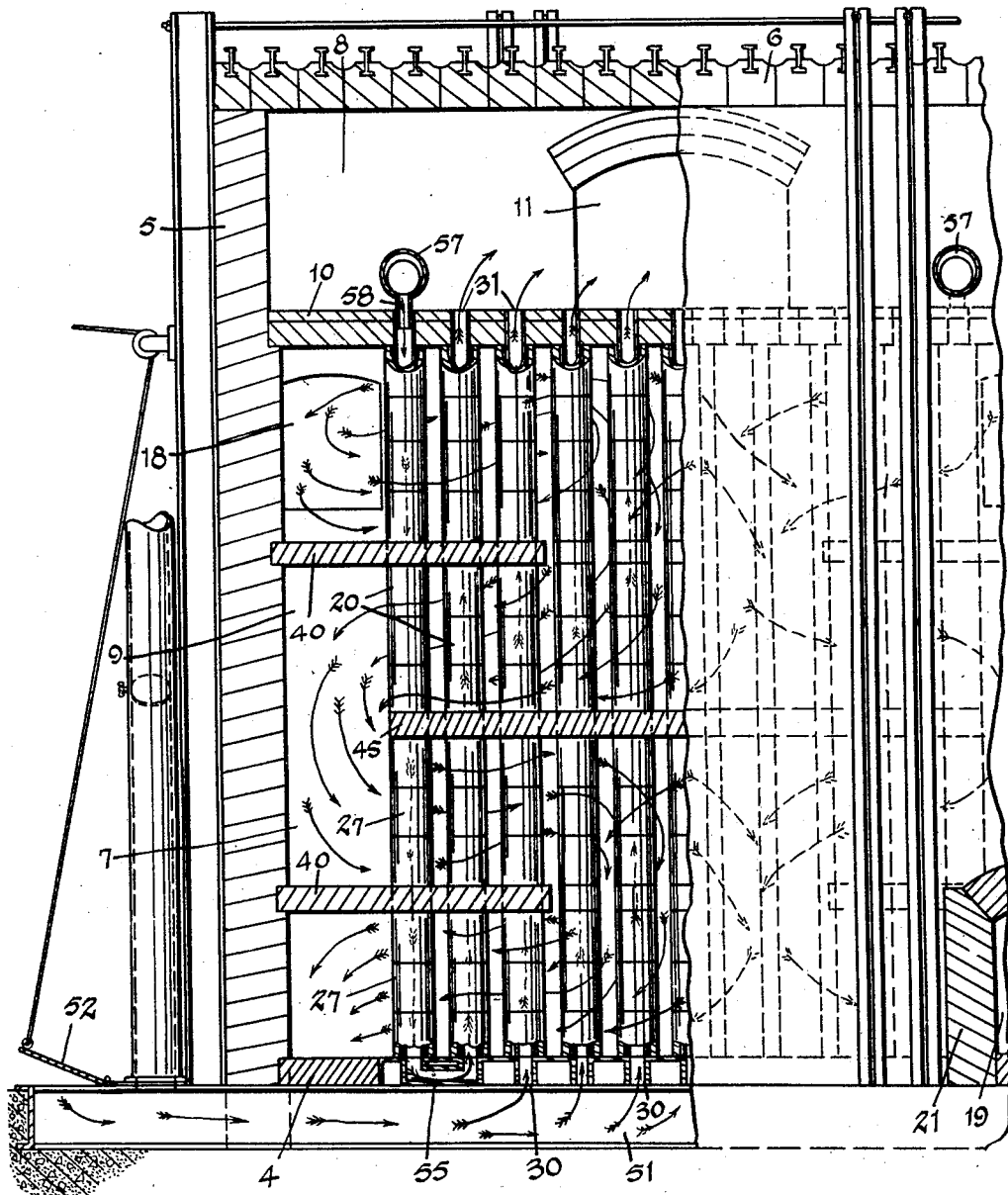


Fig 2

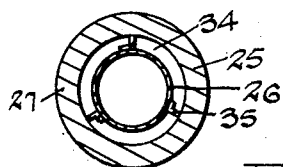


Fig 4

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4 Sheets-Sheet 3

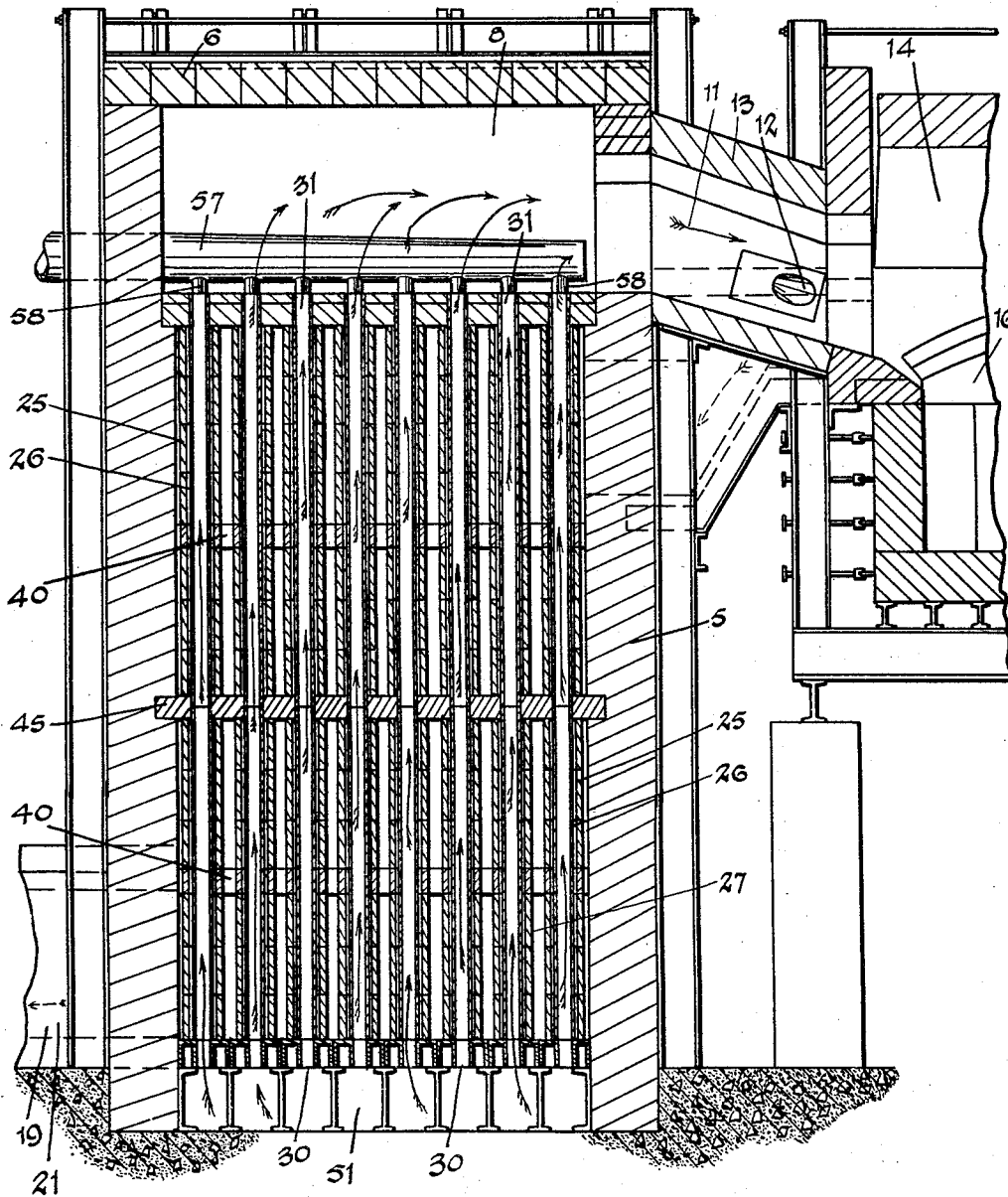


Fig 3

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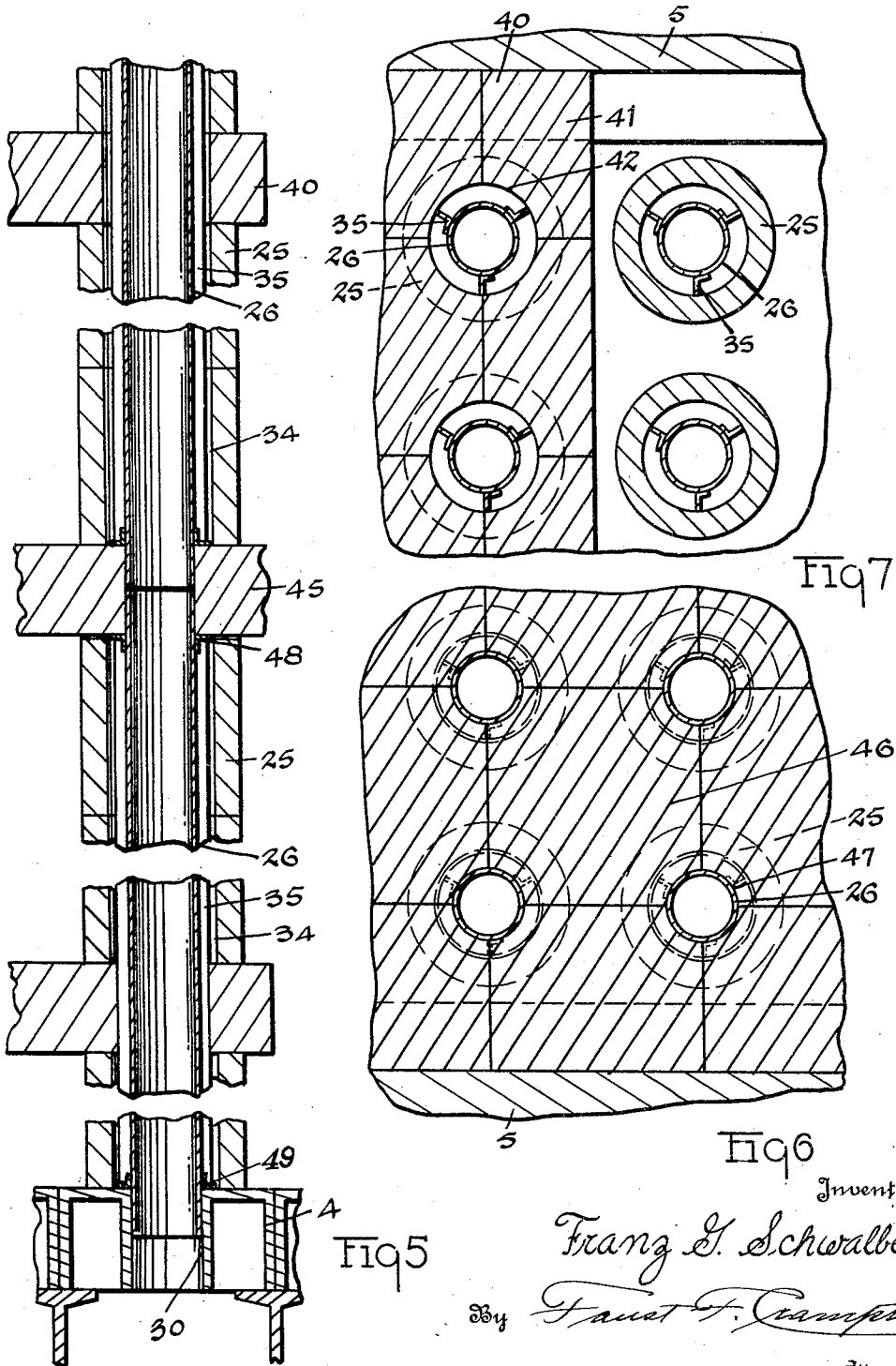
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UNITED STATES PATENT OFFICE

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RECUPERATOR CONSTRUCTION

Application filed January 10, 1931. Serial No. 507,791.

My invention has for its object to provide a recuperator for furnaces in which high temperatures necessarily prevail, in keeping with the use to which the furnace is put, such as a glass furnace. The invention has for its particular object to provide a recuperator construction which will transmit heated air, which is caused to move through passageways by variations of pressure, which passageways will be immune from distortion or cracking, to a fuel mixing locality to insure proper oxidation of the fuel.

Another object of my invention is to provide baffles so interconnected with the passageways through which the heated air is conveyed as to support and apportion the weight of parts of the passageways to be borne by other parts of the passageway, the forms and constructions of which are adaptable to withstand these weights.

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 to their details and still embody the invention. To illustrate a particular application of the invention I have selected a recuperator construction embodying the invention as an example of the various structures and details of such structures that contain the invention and shall describe the selected structure hereinafter, it being understood that variations may be made and that certain features of my invention may be used to advantage 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 illustrates a top view of the recuperator, a part of the top wall being shown broken away. Fig. 2 illustrates a view taken on the plane of the line 2—2 indicated in Fig. 1. Fig. 3 illustrates a view taken on the plane of the line 3—3 indicated in Fig. 1. Fig. 4 is a cross sectional view of one of the passageways or tube units of the recuperator. Fig. 5 illustrates a longitudinal section of one of the passageways or tube units of

the recuperator. Fig. 6 illustrates a view of a part of the middle baffle of the recuperator. Fig. 7 illustrates a view of a part of other of the baffles located in the recuperator.

In the operation of furnaces in which high temperatures are maintained, and in which it is necessary, in order to operate the furnace efficiently and at a low cost, to mix with the fuel burned in the furnace certain quantities of heated air preparatory to the ignition of the fuel, recuperators are provided to convey the air to the mixing localities and to warm it enroute by the warm exhaust gases previously given off by the furnace. Heretofore, air has been conveyed to the mixing localities by means of tubes formed of clay materials. The tubes have been joined with one another by means of other plastic clay materials in a manner well known in the art. These tubes were located so that the exhaust gases from the furnace, which are often of a temperature of approximately 2300 degrees F., impinge directly on the tubes to heat them and consequently the air being conveyed therethrough. Because of this intense heat the clay tubes will erode and often crack due to expansion and contraction, as likewise, will the material which serves to join them and the exhaust gases will enter through the cracks into the tube and mix with the air which decreases the efficiency of the established mixing ratio of the air with the fuel, or the air will escape from the tube through the cracks into the exhaust gas chamber which likewise disturbs the established mixing ratio. The escape of air from the tubes through the cracks will be increasingly evident if the air passing through the tube is impressed by a blow fan or the like. Cracking or breaking of the tubes often causes an abandonment of operation of the furnace pending repairs or replacements. The cost of these periods of inactivity are relatively high and reduce the cost efficiency of the furnace as a whole.

A furnace having a recuperator partaking of the advantages of my invention will not be subjected to periods of inactivity and of consequently increased overhead because of cracking or breaking of the tubes within the

recuperator. A recuperator encompassing the features of my invention, as herewith set forth, has passageways or tube units through the heated chamber that are made up of a pair of tubular shells. The tubular shells are located one within the other and are partially heat insulated from each other by a chamber substantially filled with a heat transmissionally resistant material. The outer tubular shell of the tube unit may be formed of clay materials and the inner tubular shell may be formed of commercial high temperature resistant, chrome iron metal tubing. The tubular shells are held one within the other in a spaced relation so that the inner tubular shells will be substantially surrounded by heat insulating air chambers. Consequently, the outer tubular shells which are subjected directly to the heat of the exhaust gases from the furnace at about 2300 degrees F. will transmit their heat by radiation to the inner tubular shells and through the insulating body. The resistance to heat flow establishes a temperature gradient between the outer surface of the clay tube, or shell, and the inner surfaces of the clay shell and also between the inner surface of the clay shell and the outer surface of the metal tube, or shell. Owing to the high conductivity of the metal tube, or shell, there is very little temperature gradient between its outer and inner surface and consequently the temperature of the tube closely approximates that of the air which is being preheated which results in a temperature well within a safe temperature range of the metal of the inner shells, or tubes. Thus, the inner tubular shells will not be subjected to distorting heat strains and cracks or openings will not be formed therein through which the air or gases may move and the inner tube will not be moved relative to the outer tube due to heat expansion, but will expand through the same distances as the outer tube expands when the outer tube is subjected to exhaust gases. Thus, air may be blown through the inner tubular shells to the mixing localities or it may be caused to move by creation of a draft or suction, as by a chimney, through the inner tubular shells.

The recuperator shown for purpose of illustration has suitable walls 5 which are supported on a flooring 4 and is covered by a suitable roof 6 to form a chamber 7. The chamber 7 is divided into two compartments, an upper compartment 8 and a lower compartment 9, by a horizontally extending wall 10. The upper compartment 8 of the chamber 7 communicates with a furnace 14 through a passageway 11. A port 12 may be located in the walls 13 of the passageway 11 through which the fuel may be introduced preparatory to its ignition in the furnace 14. Thus, the passageway 11 forms a mixing locality wherein the fuel and the heated air introduced from the upper compartment 8 of the

chamber may combine to insure complete and efficient oxidation of the fuel.

The air is heated in the lower compartment 9 of the chamber by the exhaust gases given off from the furnace 14. The furnace is connected to the lower compartment 9 of the chamber 7 through passageways 15 which have openings 16 in the furnace 14 so as to withdraw the burnt gases through the passageways 15 and into the lower compartment 9 of the chamber through openings 18 formed in the chamber wall 5. The air which is being heated and conveyed to the upper compartment passes through a plurality of tube units 20. In order to withdraw the exhaust gases from the lower compartment 9 of the chamber 7 as they become cooled, openings 19 are located in the bottom portion of the wall 5 and communicate with passageways 21, which are connected with a suitable stack. Thus, it will be seen that the exhaust gases will be drawn about the tube units 20 to heat the air passing through the tube units and the gases then allowed to escape.

The tube units 20 are constructed so as to have outer tubular shells 25 formed of short tubes 27 of clay material connected together and inner tubular shells 26 formed of metal tubing. The tubular units 20 are located in the lower compartment 9 of the chamber 7 so as to connect openings 30 formed in the flooring 4 of the recuperator with openings 31 formed in the partitioning wall 10. The openings 30 and 31 are substantially of the same diameter as the external diameter of the inner tubular shells 26 which are readily insertable within the openings 30 and 31 to prevent escape of exhaust gases from the lower compartment 9 of the chamber 7 through the openings. Each outer tubular shell 25 is located so as to surround the openings 30 and 31 and is secured in position by suitable cementitious materials. In order to support and locate the inner tubular shell 26 within the outer tubular shell 25 so that a chamber 34 may be provided to contain a heat resistant element intermediate the walls of the tubular shells, a plurality of runners or strips 35 of angle iron may be suitably attached as by welding, to the outer surface of the inner tubular shell 26 so as to extend along the inner tubular shell. By reason of the knife-like edges of the strips 35 which are in contact with the outer tubular shell 25, the conduction of heat from the outer tubular shell to the inner tubular shell will be low. The inner tubular shell 26 is thus protected from the intense heat of the gases which would cause thermal expansion of the material of which the shell 26 is formed to an extent where it would be displaced from its normal and installed position with reference to the shell 25 which is formed of a material having a low coefficient of thermal expansion. The dimensions of the chamber 34 or the

quantity or quality of the heat resistant element in the chamber may be varied to effect an equal thermal expansion of both the tubular shells when the outer shell is subjected to the heat of the exhaust gases. The heat

transmitted to the shell of high thermal expansibility through the chamber 34 and the heat resistant element contained therein from the outer shell will be of such degree as to cause a thermal expansion of the inner tube equal to the expansion of the outer tube. Thus, the inner tubular shell is located in a spaced relationship on the inside of the outer tubular shell 26 and around which the exhaust gases of the furnace are caused to swirl.

To direct the exhaust gases so that they will impinge on all the tube units 20 located in the lower compartment of the chamber a plurality of baffles 40 are located horizontally in the lower compartment of the chamber. The baffles 40 may be formed of blocks 41 of clay materials which are resistant to high temperature and extend from and are supported by the walls 5 of the chamber. The baffles 40 are connected to the outer tubular shell of the tube units 20 by blocks 41 which surround the tubular units 20 and are provided with inwardly rounded corners 42 having a radius substantially the radius of the interior surface of the outer tubular shell 25. Thus the baffles 40 will be supported by the outer tubular shells 25 and the wall 5 and will serve to support portions of the outer tubular shells 25.

In order to apportion the weight and burden of the tubular shells 25 and also to provide an added baffle, a platform 45 is provided. The platform 45 may be located substantially horizontally and centrally in the lower compartment of the chamber and may be formed of blocks 46 of clay material resistant to heat. The platform 45 is located about the tube units 20 and spaces the tube units so as to allow exhaust gases to circulate between the tube units. The blocks 46 which surround the tube units 20 have inwardly rounded corners 47 which have a radius substantially the same as the radius of the outside surface of the inner tubular shell 26. A collar 48 formed of angle iron may be secured to each inner tubular shell 26 for sustaining the bottom corner of the blocks 46. Thus the weight of the short tubes 27 which form the upper part of the outer tubular shell 25 and which are built above the platform 45 will be supported on the collars 48 by the inner tubular shell 26. The expansion, by reason of heat transmitted to the inner tubular shell 26 to which the collars 48 are connected will be substantially the same as the expansion of the shell 25 per unit length and thus prevents separation of the short tubes 27, which form the outer shell, away from each other at the points of jointure of the tubes 27 at which the column of tubes 27 are con-

nected to the collar 48. This feature of construction lessens the weight borne by the short tubes 27 forming the lower half of the outer tubular shells of the tube units 20 and places part of that weight on the inner tubular shells 26.

The inner tubular shells 26 may be supported by the rings 49, formed of angular iron, that are supported on the floor 4 and so as to locate the lower ends of the tubes or shells 26 in the openings 30.

The openings 30 communicate with passageways 31 which may be controlled by a suitable damper 52. The damper 52 will control the air passing through the passageways 51 and consequently through the openings 30 and the inner tubular shells 26 to the mixing localities.

In order to provide for a forced draft of air through the tube units 20 and to decrease the operating temperature of the first row of tubes at their upper ends, a number of tube units may be connected together at their openings 30 by U-shaped pipes 55. The air is introduced into the tube units which are so connected by means of a suitable blow fan which directs the air through the pipes 56 and the pipe 57 which extends into the upper compartment 8 of the chamber 7. The pipe 57 is connected to one of each pair of tube units by a series of teats 58 which substantially fit the openings 31 in the wall 10. The openings 31 communicate with one of each pair of tube units 20 as connected together by the U-shaped pipe. Thus the air may be driven downwardly through one of the pair of joined tube units 20 through the U-shaped pipe 55 and upwardly through the second of the pair of joined tube units to the mixing locality. The amount of air being conveyed to the mixing locality may be easily varied to maintain efficient burning of the fuel by varying the volume of the air introduced in the tube units 20.

I claim:

1. In a recuperator having a plurality of vertical tube units, each tube unit comprising a tubular shell and a plurality of superimposed tubular shells of substantially the same diameter and arranged coaxially with the first named tubular shell, means connected to the first named tubular shell for supporting the weight of certain of the second named tubular shells and means for maintaining the walls of the inner and outer tubular shells in spaced relation to each other.

2. In a recuperator having a plurality of vertical tube units, each tube unit comprising a pair of concentric tubular shells, the outer surface of the inner shell having longitudinally extending spacer strips and means for connecting the outer shell to the strips for supporting the weight of the outer shell on the inner shell.

3. In a recuperator having a plurality of

vertical tube units, each tube unit comprising a tubular member and a plurality of superimposed shells of substantially the same diameter and arranged coaxially with the tubular member, baffle members extending horizontally with reference to the tube units, and metal strips extending parallel to the axes of the tubes and located intermediate the tubular member and the shells for maintaining and supporting the shells in spaced relation to the tubular member and means for connecting the strips to the baffle members for supporting the baffle members.

4. In a recuperator having a plurality of vertical tube units, each of the tube units comprising a pair of concentric tubular shells, one of the said pair of shells formed of fired plastic earthen materials and the other of said pair of shells formed of metal, means located intermediate the said pair of shells for locating the first named shell upon the second named shell and for forming sealed chambers between the shells resistant to the transmission of heat from one shell to the other.

5. In a recuperator having a plurality of vertical tube units, each tube unit comprising a tubular member and a plurality of superimposed tubular shells of substantially the same diameter and arranged coaxially with the tubular member, the tubular shells being formed of fired earthen materials, means for connecting the tubular member to the tubular shells for supporting the weight of portions of the tubular shells and for preventing the said supported tubular shells from exerting a pressure on adjacent tubular shells to cause cracking and crumbling of the walls of the tubular shells.

6. In a recuperator having a plurality of tube units, each of the tube units comprising a pair of concentric tubular shells of different diameter, one of said pair of shells formed of a material having a coefficient of thermal expansion different from that of the material from which the other of the said pair of tubular shells is formed, and spacer strips located between the tubular shells to form chambers resistant to heat transmission from one shell to another for effecting substantially equal thermal expansion of the shells upon application of heat to the shell formed of a material having the lower coefficient of expansion.

7. In a recuperator having a plurality of tube units, each of the tube units comprising a pair of concentric tubular shells, means located between the shells for forming chambers resistant to the transmission of heat to control the thermal expansion of one of the said pair of shells upon application of heat to the other of the said pair of shells.

In witness whereof I have hereunto signed my name to this specification.

FRANZ G. SCHWALBE.