United States Patent

Hurko et al.

[15] 3,659,646

[45] May 2, 1972

[54] HEAT EXCHANGER CONSTRUCTION

[72] Inventors: **Bohdan Hurko; Raymond L. Dills**, both of Louisville, Ky.

[73] Assignee: **General Electric Company**

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[52] U.S. Cl. ....165/164, 126/21 A

[51] Int. Cl. F28d 9/00

[58] Field of Search ....165/164, 170, 171, 183; 126/21, 21 A

[56] **References Cited**

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3,507,265	4/1970	Hurko et al.	126/21
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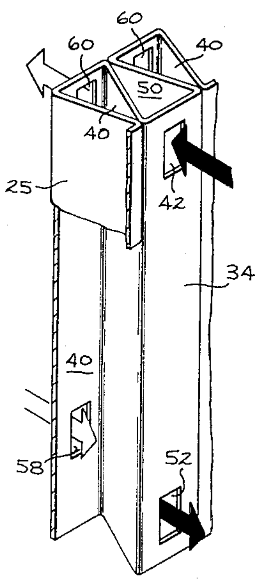
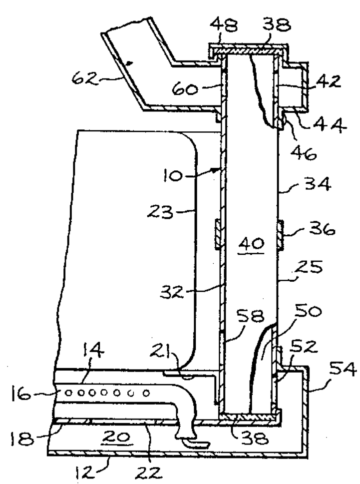
[57] **ABSTRACT**

A heat exchanger for use in the flue gas exhaust system of a self-cleaning gas cooking oven in the form of a large square-cornered corrugated panel that is collapsed from the sides in the plane of the panel to create two intermeshed series of triangular shaped pipes where one series of alternate pipes carry hot flue gases while the opposite series of alternate pipes carry inlet air for transferring some of the heat of the flue gases to the ambient air. The front face of the heat exchanger that is turned toward the oven operates hot, while the back face of the heat exchanger operates relatively cool to reduce heat losses to the outside. Sealing means close both the top and bottom ends of the pipes. Inlet and outlet openings are formed in the front and back faces of the unit near the top and bottom.

9 Claims, 6 Drawing Figures





Patented May 2, 1972 3,659,646

FIG. 4

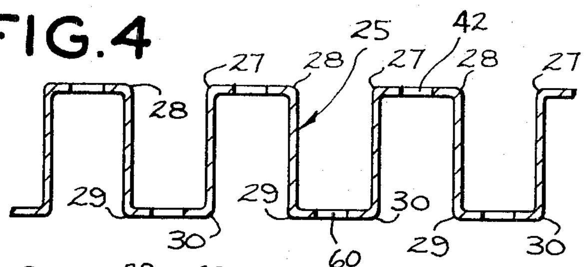


FIG. 2

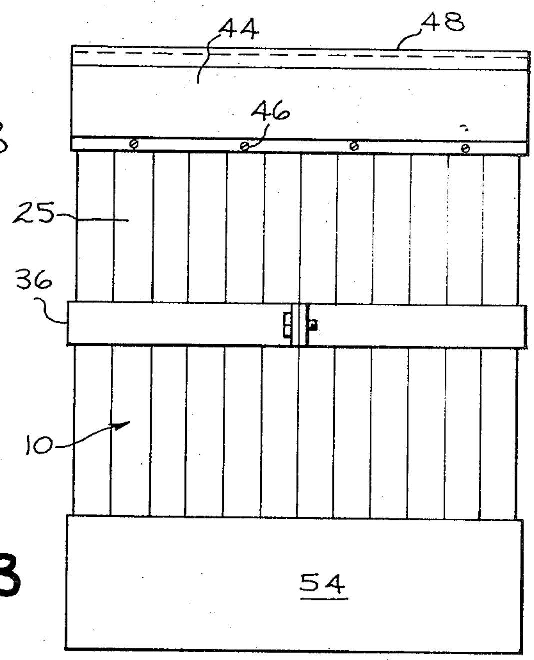


FIG. 5

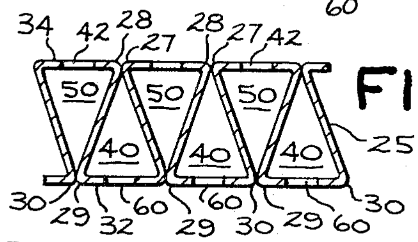


FIG. 3

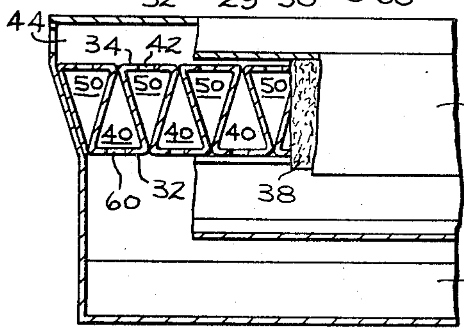


FIG. 6

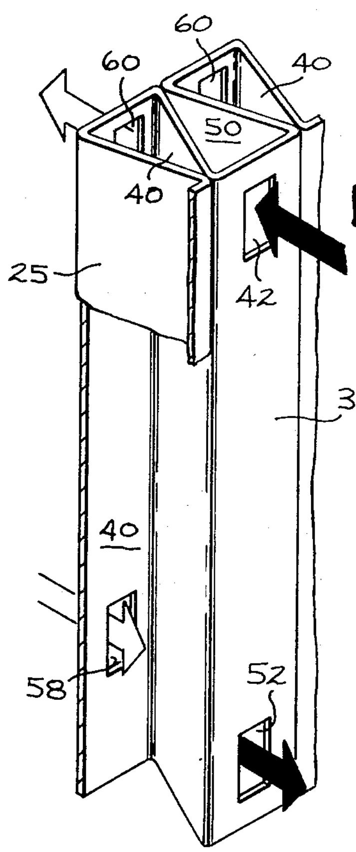
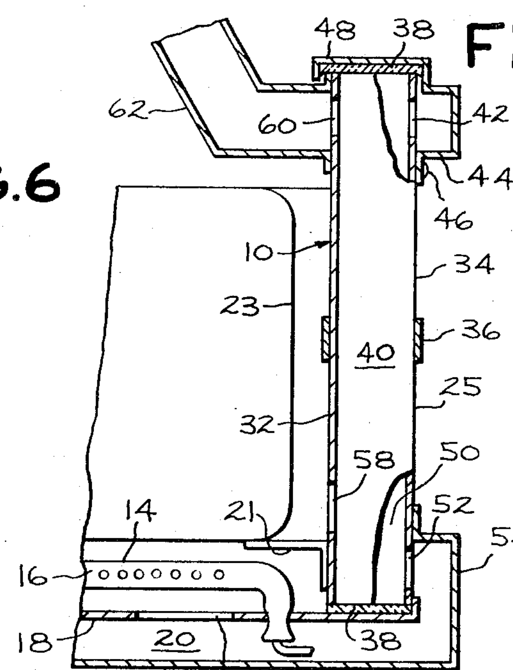


FIG. 1



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HEAT EXCHANGER CONSTRUCTION

CROSS-REFERENCE TO RELATED APPLICATION

The present invention of a heat exchanger construction is illustrated with the self-cleaning gas oven invention disclosed in the copending patent application Ser. No. 46,113 of Bohdan Hurko and James A. Dooley, entitled SELF-CLEANING GAS OVEN WITH HEAT EXCHANGER, which was filed concurrently herewith and is assigned to the General Electric Company, the assignee of the present application.

BACKGROUND OF THE INVENTION

The present invention was developed while working toward improved designs of pyrolytic or high temperature self-cleaning gas cooking ovens wherein food soils and grease spatters that had formed on the inner walls defining an oven cooking cavity are degraded into gaseous products that are completely oxidized before they are returned to the kitchen atmosphere. In such a self-cleaning oven the temperatures rise above about 750° F. and as high as about 950° F. for a sufficient time to complete the transformation, on the order of 1 to 3 hours. In a gas oven only about one-half of the heating value of the gas consumed is used for heating the oven. The remainder is represented by both the heat of exhaust and the heat losses radiating outwardly from the walls of the oven body or cabinet. Hence, while it is necessary to raise the temperature of the walls forming the oven cooking cavity into the self-cleaning temperature range, it is imperative to avoid pumping a large amount of hot flue gases back into the kitchen atmosphere. It is most desirable from a personal safety standpoint to hold down the exhaust temperature of the flue gases below a maximum of about 550° F. for any cooking operation. This same temperature limit is also desirable for the automatic oven cleaning operation.

A related patent on this subject is one of the present inventors, U.S. Pat. No. 3,507,265, entitled SELF-CLEANING GAS COOKING OVEN, which discloses a heat exchanger in combination with the oven for both reducing the temperature of the flue gases as well as preheating the secondary air for the gas burner means.

The principal object of the present invention is to provide a heat exchanger having as its main component a single panel having two intermeshed series of pipes where one series of alternate pipes carry hot flue gases while the opposite series of alternate pipes carry ambient air for transferring some of the heat of the flue gases to the ambient air.

A further object of the present invention is to provide a heat exchanger of a collapsed corrugated panel to form a hot front face turned toward the source of heat and a cool back face so as to reduce the heat losses to the outside.

A still further object of the present invention is to provide a heat exchanger of the class described with sealing means at the top and bottom of the exchanger, and inlet and outlet openings in the front and back faces thereof to create the proper flow patterns.

SUMMARY OF THE INVENTION

The present invention, in accordance with one form thereof, relates to a heat exchanger having two intermeshed series of pipes formed by a corrugated panel of sheet metal material that is collapsed from the sides to close the corrugations and form substantially flat front and back faces. Clamping means hold the corrugations closed so that there is one series of alternate pipes adapted to carry hot gases while the opposite series of alternate pipes is adapted to carry relatively cool gases for transferring some of the heat of the hot gases to the cool gases.

BRIEF DESCRIPTION OF THE DRAWINGS

Our invention will be better understood from the following description taken in conjunction with the accompanying drawings and its scope will be pointed out in the appended claims.

FIG. 1 is a fragmentary transverse, cross-sectional, elevational view through the back end of a gas oven having a heat exchanger embodying the present invention showing a counterflow system where the hot flue gases flow upwardly in a chimney-like manner, while an ambient air flow moves from top to bottom and empties into a firebox in which is disposed a gas burner which when ignited serves to create a draft that draws the ambient air down through the heat exchanger and pass the hot flue gases up through the heat exchanger.

FIG. 2 is a back side elevational view of the heat exchanger of FIG. 1 showing the cool face of the exchanger which would be turned to the outside of the oven so as to reduce the heat losses to the outside.

FIG. 3 is a fragmentary top cross-sectional plan view in a plane generally through the air inlet openings and the flue gas outlet openings to look directly down through the pipes where the heat transfer takes place between the hot gases and the cool air, as well as showing the resilient sealing material used for closing the ends of the pipes.

FIG. 4 is a fragmentary cross-sectional plan view on a slightly enlarged scale of a square-cornered corrugated panel of thin sheet metal material which is the starting material for this heat exchanger and which is to be fashioned into the final configuration. This FIG. 4 is also taken on the plane through the air inlet openings and the flue gas outlet openings that are in the back and front faces of the heat exchanger, respectively.

FIG. 5 is a cross-sectional plan view similar to that of FIG. 4, but after the panel of FIG. 4 has been compressed at the sides in the plane thereof so as to close the corrugations and hold them closed to form two intermeshed series of triangular shaped pipes, where one series of alternate pipes carry hot flue gases in an upward direction while the opposite series of alternate pipes carry ambient air in a downward direction to establish a counterflow pattern.

FIG. 6 is a fragmentary perspective view of the closed corrugated panel construction of the heat exchanger of the present invention showing that the corrugations are not welded or brazed shut, but merely closed and held together by compressive pressure exerted on the opposite sides of the corrugated panel in the plane thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to a consideration of the drawings and in particular to FIG. 1 there is shown a counterflow heat exchanger **10** as it would be assembled across the back side of a self-cleaning gas cooking oven. The lower portion of FIG. 1 does show some gas oven structure in order to illustrate the environment in which this invention may be placed and operated advantageously. A bottom wall of the oven body is shown as plate **12**. A firebox **14** is positioned in the lower portion of the oven and it is adapted to contain a gas bake burner **16**. A shield **18** underlies the gas burner **16** and forms an air channel **20** therebeneath. This shield **18** is provided with a series of elongated slots **22** which are disposed directly beneath the burner **16** for providing secondary air flowing around the outside of the burner during the operation of the burner. An angle iron **21** is mounted across the back of the oven body to form a support for the rear of a box-like oven liner **23**. The bottom wall **24** of the oven liner serves as the top wall of the firebox **14**.

The heat exchanger **10** can best be understood by tracing the various steps in manufacturing the unit. Attention is first directed to FIG. 4 which shows a cross-sectional plan view of a square-cornered corrugated panel **25**. This panel may have a height the same as the oven liner with which the heat exchanger is to be combined, although this may vary depending upon the size of the oven, the heating rates of the burners and the temperature ranges encountered without departing from the scope of the present invention. This particular corrugated pattern has rather sharp radii **27**, **28** and **29** and **30**, and a generally alternate rectangular, zig-zag or serpentine cross-section. This panel **25** is made of thin sheet metal material such as aluminum or stainless steel and such thin metal stock has a normal tendency to collapse into the closed configuration shown in FIG. 5. Notice that the corners 28 have been closed against the opposing corners 27, while the corners 30 have been closed against the corners 29 thereby forming a front face 32 and a back face 34 which may be considered as being separated by a hollow core represented by two intermeshed series of triangular shaped pipes 40 and 50. One series of alternate pipes 40 carry hot flue gases, while the opposite series of alternate pipes 50 carry ambient air. This compressed corrugated panel 25 is held in this form by a tension strap 36 best shown in FIG. 2 around the middle of the panel so that the corrugations may not open up.

Now returning to FIG. 1, it should be noticed that the top and bottom ends of the pipes 40 and 50 of the heat exchanger are sealed by a resilient pad 38 such as fiber glass or the like. This sealing means tends to prevent intermixture of the flue gases of pipes 40 with the ambient air of pipes 50. These pipes 40 and 50 now become individual pipes, and other means must be provided for the gas and air to gain entry into and exhaust from such pipes. The front face 32 of the heat exchanger is adapted to be turned toward the back side of the oven, while the back face 34 is facing away from the oven. In this back face 34, a series of spaced air inlet openings 42 are formed in the top portion thereof communicating with the alternate pipes 50, as is best seen in FIG. 6. A manifold 44 is assembled over the plurality of air inlet openings 42 as is seen in FIGS. 1 and 2. Ambient air is allowed to flow into the opposite ends of the manifold 44 since the ends are left open. This manifold also tends to space the heat exchanger 10 away from any kitchen wall against which the oven might be placed, such that the kitchen wall will not tend to block the air movement through the heat exchanger. This manifold 44 is adapted to be fastened in place by screw means 46 which extend through openings in a bottom flange thereof and are threaded into the back face 34 of the heat exchanger. The top portion 48 of the manifold 44 is adapted to fit over the resilient pad 38 in the manner of a cover plate and hold the pad in place. Similar air outlet openings 52 are formed in the bottoms of the pipes 50, as is also shown in the perspective view of FIG. 6.

An elongated collecting box 54 is assembled across the air outlet openings 52 for receiving the air as it exits from the bottom of the heat exchanger 10. This box 54 supplies the air to the bottom air channel 20 from which it rises through the slots 22 in the shield 18 for passing over the gas burner 16 as preheated secondary air.

The hot flue gases from the burner 16 are adapted to raise the temperature of the oven cooking cavity (not shown). After this occurs the gases are to be expelled to the atmosphere. However, in the present invention the flue gases are adapted to flow through the heat exchanger 10 first. This may be done either as a parallel flow or a counterflow pattern. A parallel flow pattern might have the air and flue gases entering at the top of the heat exchanger and the heater air and the flue gases at reduced temperature exhausting at the bottom of the heat exchanger. This might require a forced draft of the flue gases through the heat exchanger. The counterflow system is illustrated in the present drawings. Flue gas inlet openings 58 are formed in the bottom portion of the front face 32 of the heat exchanger for communication with the alternate pipes 40, while flue gas outlet openings 60 are formed in the top portion of the alternate pipes 40, where the gases pass into an inclined exhaust duct 62 which extends to the underside of a backsplash (not shown) of a gas range in which the oven is mounted, where they are returned to the kitchen atmosphere. FIG. 1 shows a muffle oven design where the flue gases pass from the firebox 14 around the outside of the oven liner 23 and then down the back thereof where they enter into the series of spaced flue gas inlet openings 58. Of course, a flow-through heating system could also employ the heat exchanger of the present invention.

Having described above our invention of a simplified, low cost and highly efficient heat exchanger construction of substantially one piece, it will be readily apparent to those skilled in this art that we have provided a design where one face, the front face 32, operates at a high temperature and is disposed facing the source of the hot flue gases; namely, the oven liner 23, while the opposite face or back face 34 of the heat exchanger is a cool face and it is facing away from the oven. This relationship tends to reduce the heat losses to the outside of the heat exchanger and hence the outside of the range or oven. It also tends to maintain the back wall of the oven liner 23 at generally uniform high temperatures so as not to develop cold spots at the back of the oven which might otherwise require the burning of more fuel gas in order to raise the minimum oven temperatures to the necessary amount.

Modifications of this invention will occur to those skilled in this art, therefore, it is to be understood that this invention is not limited to the particular embodiments disclosed, but that it is intended to cover all modifications which are within the true spirit and scope of this invention as claimed.

What is claimed as new and is desired to be secured by Letters Patent of the United States is:

1. A heat exchanger for use in the flue gas exhaust system of a self-cleaning gas oven, said heat exchanger comprising a folded corrugated panel with two intermeshed series of triangular shaped pipes, one series of alternate pipes being adapted to carry ambient air and the other series of alternate pipes being adapted to carry hot flue gases, whereby one face of the heat exchanger is a relatively cool face and the opposite face is a hot face, sealing means at each end of the heat exchanger for closing the ends of the pipes and preventing intermixture between the air and gases of the two series of pipes, air inlet and outlet openings formed at opposite ends of the pipes at the cool face and flue gas inlet and outlet openings formed at opposite ends of the pipes at the hot face.

2. A heat exchanger comprising two intermeshed series of triangular shaped pipes formed by a square-cornered corrugated panel that is closed to form a front and a back face, one series of alternate pipes being adapted to carry hot gases and another series of alternate pipes adapted to carry ambient air, sealing means at each end of the heat exchanger for closing the ends of the pipes and preventing intermixture of the air and gases, the front face of the heat exchanger having gas inlet openings at one end and gas outlet openings adjacent the opposite end, the back of the heat exchanger having air inlet openings at one end and air outlet openings adjacent the opposite end.

3. A heat exchanger as recited in claim 2 wherein the heat exchanger has a counterflow system with the gas inlet openings and the air inlet openings at opposite ends of the heat exchanger, while the gas outlet openings are adjacent the air inlet openings and the air outlet openings are adjacent the gas inlet openings.

4. A heat exchanger as recited in claim 3 wherein the heat exchanger is adapted to be vertically arranged with the gas inlet openings arranged adjacent the bottom to create a chimney effect with the hot gases rising through the heat exchanger, while the air inlet openings are arranged adjacent the top of the heat exchanger and the air is adapted to flow downwardly through the heat exchanger by a suction created downstream of the air outlet openings.

5. A heat exchanger having two intermeshed series of pipes formed by a square-cornered corrugated panel of thin walled sheet metal material that is collapsed from the sides to close the corrugations and form a substantially flat front and back face, clamping means for holding the corrugations closed, one series of alternate pipes being adapted to carry hot gases while the opposite series of alternate pipes is adapted to carry relatively cool gases for transferring some of the heat of the hot gases to the cool gases.

6. A heat exchanger as recited in claim 5 wherein sealing means close the opposite ends of the pipes, inlet openings for the hot gases through the bottom portion of the front face, outlet openings for the hot gases through the top portion of the front face, whereby the front face operates at a relatively high temperature, inlet openings for the cool gases through

the top portion of the back face, outlet openings for the cool gases through the bottom portion of the back face whereby the back face operates at a relatively low temperature.

7. A counterflow heat exchanger for use in the flue gas exhaust system of a self-cleaning gas oven, said heat exchanger comprising a corrugated panel of thin sheet metal material that is collapsed transversely in the plane of the panel to close the corrugations and to form two intermeshed series of pipes where one series of alternate pipes is adapted to carry hot flue gases while the opposite series of alternate pipes is adapted to carry ambient air for transferring some of the heat from the flue gases to the ambient air, and clamping means for holding the corrugations closed, the front face of the heat exchanger being near the flue gas pipes and operating relatively hot while the back face of the heat exchanger is nearest the ambient air pipes and it operates relatively cool, the front face being disposed toward the source of hot flue gases while the back face is disposed toward the outside.

8. A counterflow heat exchanger as recited in claim 7 wherein the corrugated panel has right-cornered corrugations which when collapsed in the plane of the panel form two intermeshed series of triangular shaped pipes where the front series of pipes is adapted to carry the hot flue gases while the back series of pipes is adapted to carry the ambient air.

9. A counterflow heat exchanger as recited in claim 8 including sealing means at the opposite ends of the pipes for closing the pipes, gas inlet openings in the front face of the heat exchanger adjacent the bottom portion thereof, gas outlet openings in said front face adjacent the top portion thereof, air inlet openings in said back face adjacent the top portion thereof and air outlet openings in said back face adjacent the bottom portion thereof, and suction means adapted to be connected to the air outlet openings for drawing the ambient air down through the heat exchanger.

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