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[56]

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UNITED STATES PATENTS

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[54] APPLIANCES EMPLOYING CHECKER-BOX REGENERATORS

10 Claims, 3 Drawing Figs.

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166, 170, 238; 126/21 A, 39 J; 110/8 A; 263/19

ABSTRACT: The application discloses improved checker-box-type regenerators in combination with gas-fired domestic or commercial appliances, such as home incinerators, cooking ovens, smooth top ranges, mangles and the like, employing single, double, and plenum-type heating or combustion chambers. The input ambient air is preheated as it passes through a checker-box, and is then ducted to the appliance. The hot exhaust air and gases pass countercurrent through another section of an adjacent checker-box and are thereby cooled. The cooled flue products may be vented directly into the room wherein the appliance is situated if desired, without technical or safety problems arising, codes permitting. The use of the regenerator is in accordance with a process in which the rate of heating in the appliance is controlled.

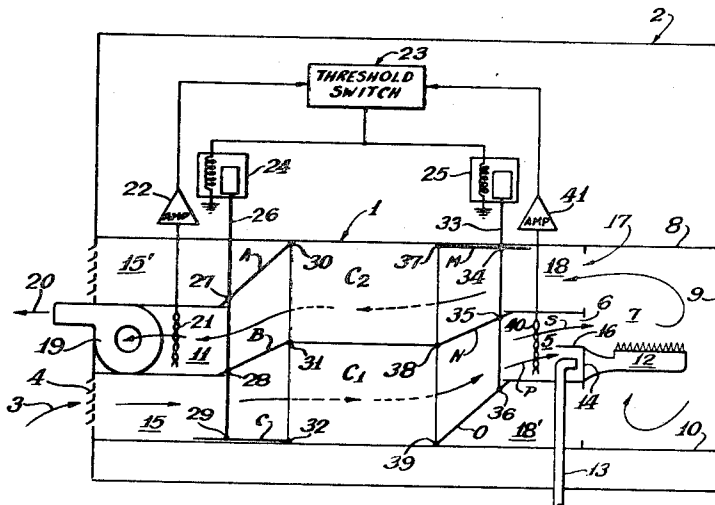
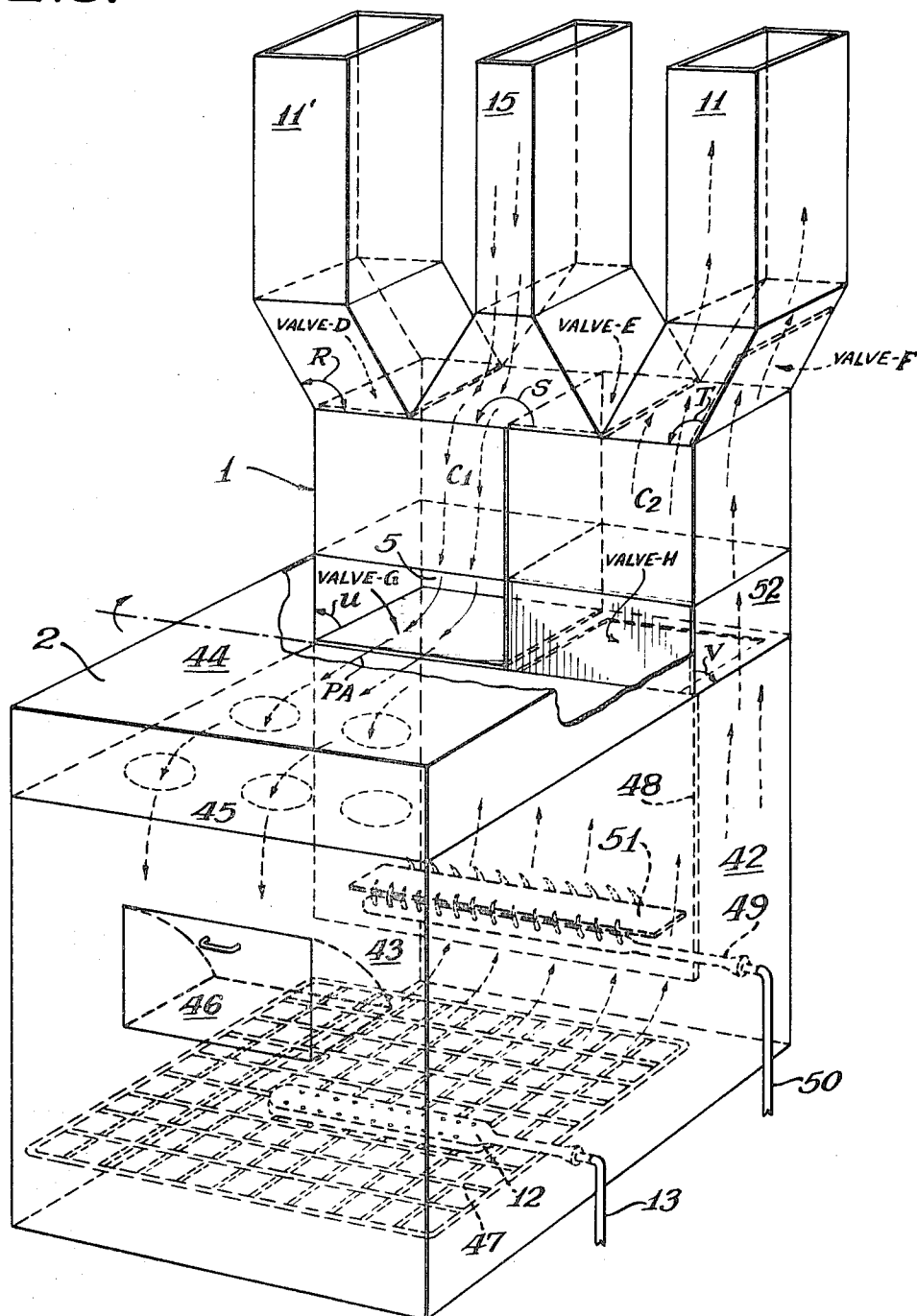


FIG. 3.



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APPLIANCES EMPLOYING CHECKER-BOX REGENERATORS

FIELD AND PRIOR ART

The field of this invention is that of improved means for control of airflow patterns in gas-fired appliances particularly useful in domestic applications, although the concept of the invention is equally applicable to nonindustrial, commercial devices.

Gas-fired appliances per se are known in the art, and rotary regenerative heat exchangers to preheat incoming air are shown in Huebler U.S. Pat. No. 3,416,509. However, one of the disadvantages of such regenerators is that they require a power source for the rotation. Further, prior art appliances, particularly the domestic type not using heat exchangers, are wasteful of heat and require exterior venting of high insulating capacity such as masonry chimneys. This latter problem is aggravated in domestic gas ovens that perform self-cleaning.

PRESENT INVENTION

Objects

It is among the objects of this invention to provide improved control of airflow patterns in gas-fired appliances, particularly in domestic situations, that can eliminate entirely the need to vent flue products or permit the use of inexpensive venting. It is another object of this invention to provide means in combination with a gas-fired appliance that lowers the flue gases temperature for room interior venting.

It is another object to provide a stationary regenerator for use in combination with gas-fired appliances that has improved duct means for control of airflow path into, through and out of the appliance to provide efficient cooling, and total energy economy without the need for rotary power sources.

Still further and other objects will be evident from the description of the invention below.

Summary

The present invention involves the use of an improved stationary heat exchanger and ducting in combination with a gas-fired appliance. More specifically, the type of heat exchanger employed is the checker-box regenerator type having two chambers which are alternately used to heat incoming air and cool exhaust gases. The regenerator is disposed in combination with the appliance so that hot exhaust gases issuing from the appliance heating chamber during heating, incinerating, baking, etc. are cooled by the first chamber to a temperature such that the exhaust gases may be vented directly into the adjacent room space. Alternatively, the exhaust gases may be vented exteriorly by means of a common Class C vent, or other conventional low temperature through-the-wall venting means, instead of the more expensive masonry chimney or Class L vents as required by prior art devices. The incoming air, which is to be combusted with the gas is simultaneously preheated by passage through the second chamber of the checker-box regenerator in countercurrent relation to the exhaust gases. After a controlled time, communicating input and exhaust ducts are switched so that the flow paths are reversed with heat energy which has been accumulating in the first chamber of the regenerator being released to the incoming air. The first chamber is cooled while the second is heated, thus completing the cycle. In the drawings:

FIG. 1 is a schematic diagram, partly in section, of one embodiment of the invention wherein a checker-box-type regenerator system is employed in combination with a gas-fired appliance and the airflow valves are disposed in a first switching position;

FIG. 2 is a schematic diagram of the invention with valves in a second switched position for the second half of the cycle; and

FIG. 3 is a perspective view, partly broken away showing an alternate embodiment of the invention particularly adapted for use on a domestic incinerator. With reference to FIGS. 1 and 2, one embodiment of the invention is a checker-box-type regenerator unit, indicated generally as 1, shown connected to

an appliance 2. The regenerator may be located on the rear of the appliance, or in any suitable location where the unit geometry permits. The appliance per se may be any conventional gas-fired appliance, preferably of the domestic type, such as an oven, smooth top range, incinerator, mangle, or the like. The appliance of our invention has appropriate controls, insulation, and heat-resistant materials of construction.

It should be understood that the term "flue gases" refers to the mixture of hot products and air passing through the appliance prior to entering the regenerative heat exchanger, and the term "exhaust gases" refers to the relatively cooler gases in the exhaust duct after having passed through the regenerative heat exchanger. In contrast to natural draft conditions, the supply of preheated air is distributed evenly by the fans and ducting throughout the appliance. By control of distribution and amount of preheated air, the heat can be regulated.

The preheated air passes into the appliance as shown by arrows in FIGS. 1 and 2 via inlet duct 15 drawn by fan 19, for example a squirrel-cage-type fan. The input air then passes through a previously heated checker-box C-1 where it is preheated. The preheated air then passes in to the appliance where it is combined with hot gases from a burner used therein to form flue gases. The preheated air may be used for either primary or secondary air, or both for the burner in the appliance.

Upon being formed, the flue gas products pass out through checker-box C-2 wherein they are cooled by giving up heat to the checker-box material, and are then exhausted out the exhaust duct 11. The exhaust or flue gases may be diluted by ambient air mixed therewith via a damper or other inlet (not shown). Where a "Cercor" or other high temperature checker-box is used, no ambient air dilution may be desired.

Items A, B and C in FIGS. 1 and 2 are valves, dampers, rotating wheels or other suitable means of closing the ducts to prevent flow in the section of ducting wherein the dampers are located. Preferred types of closures are flap-type, rotating-wheel-type or slide-type valves. The valves operate in unison to switch the intake and exhaust ducting communication from checker-box C-1 to C-2 for intake and from C-2 to C-1 for exhaust. Likewise, valves M, N and O switch in unison to reverse the communication on the flue, or interior, side of the checker-boxes. The flue side valves may be identical to those on the exterior or exhaust side, or as shown in FIG. 3.

In operation, ambient air 3 passes into duct 15 via louvers 4. Valves A, B and C are positioned as shown in FIG. 1 so that the ambient air passes through the checker-box C-1 where it is preheated. After passing through the checker-box C-1, the preheated air is ducted by means of movable baffles or valves N and O to receiving duct 5. The preheated air in receiving duct 5 passes through opening 6 into the heating chamber 7 defined by liner walls 8, 9 and 10 in the appliance 2. Some of the preheated air may be ducted to the burner 12 disposed in the cavity 7 as primary air, as shown by the airflow arrow indicated as P. The burner is supplied with fuel by means of line 13 and the preheated primary air is ducted to the mixing orifice 14 by suitable baffling 16.

All of the preheated air may be ducted to the burner 12 as primary air P, or in the alternative it may be ducted directly to the heating chamber 7 as secondary air, indicated by the airflow arrow S. A still further alternative is that the air may be divided so that there is a primary and a secondary stream as shown in FIG. 1.

It should be understood that the burner 12 need not be placed directly within the heating chamber 7, but may be placed in a plenum below the heating chamber, as in the case of some types of ovens. Likewise, there may be a plurality of burners in the appliance to which the preheated air is ducted as primary, secondary or both primary and secondary air. The burners may be of any convenient type, and the term "burner" is meant to include all types, including infrared, aspirating, and powered burners, and the like. In addition, some of the preheated air may be ducted directly to a secondary burner or flame source, as in the case of an afterburner in an incinerator,

in addition to being directed to the primary burner. An example of this type of ducting may be seen in our copending application Ser. No. 670,908 filed Sept. 27, 1967, now Pat. No. 3,509,834.

It should be understood that the heating chamber 7 is any of the types of heating chambers in gas-fired appliances. Thus, heating chamber 7 may be the baking or the broiling cavity of a domestic oven, or it may be the heating chamber below the glass or "Cer-Vit" plate used in smooth top ranges, such as seen for example in U.S. Pat. Nos. 3,241,542 and 3,494,350. A typical type of oven to which the instant invention may be applied is the gas-fired self-cleaning oven shown in U. S. Pat. Nos. 3,416,509, or 3,417,742 and 3,499,429. In the alternative, the burner 12 may be disposed in the primary combustion chamber of an incinerator and the preheated air ducted either as primary or secondary air thereto, or to the afterburner in a separate afterburner section as shown in the aforesaid copending application Ser. No. 670,908. It will be evident that the checker-box system of this invention may be applied to other domestic appliances by appropriate modification of the various ducts shown herein.

Continuing with the operation, the air heated in the heating chamber 7 passes through chamber outlet 17 into flue duct 18, and then guided by the valves M and N through the checker-box C-2. As the heated air passes through the checker-box C-2, the heat-absorbing material therein is heated while the air passing therethrough is cooled to the desired degree.

The air leaving the checker-box C-2 is ducted by means of valves A and B to the exhaust duct 11. The air is then ejected from the appliance by means of a suitable fan 19, which may conveniently be a squirrel cage type as shown in FIGS. 1 and 2. The exhaust air 20 is sufficiently cooled by the operation of the checker-box 1 that it may be ejected directly to the space surrounding the appliance, and thus expensive masonry chimneys are obviated by the practice of this invention. The lower exhaust temperatures also allow for use of a low-cost fan.

When the exhaust air in duct 11 is sufficiently hot, as sensed by the heat-sensing means 21 disposed therein, for example a thermocouple, the valves A, B and C, and the valves M, N and O are switched in unison to the positions shown in FIG. 2 and indicated as A', B', C' and M', N' and O'. The signal from the heat sensor 21 is fed to and amplified by the amplifier 22 and passed to a threshold switch 23, which in turn actuates the valve-switching means 24 and 25. The threshold switch may be preset so that a predetermined temperature level must be reached in duct 11 by the exhausting air before the switch is triggered to reverse the airflow cycle through the checker-boxes C-1 and C-2. As seen from the Figures, the valve-switching means may be a solenoid assembly 24 to which is linked an arm 26 being pivotally connected at 27, 28 and 29 to the corresponding valves A, B and C. These valves are hinged at 30, 31 and 32 respectively so that they may be pivoted in unison from the position shown in FIG. 1 to that shown in FIG. 2.

In a similar manner, the valve-switching means 25 has arm 33 pivotally connected at 34, 35 and 36 to the valves M, N and O, which in turn are pivoted at 37, 38 and 39 as shown. This provides for the switching of the valves on the interior of the checker-box from the position shown in FIG. 1 to the position shown in FIG. 2.

As seen by comparing FIGS. 1 and 2, the simultaneous switching of the interior and exterior valves, A-B-C and M-N-O, to the positions A'-B'-C' and M'-N'-O', respectively, reverses the flow passage through the checker-boxes C-1 and C-2 so that the previously heated checker-box C-2 now gives up its heat to the ambient incoming air 3 passing therethrough. The previously cooled checker-box C-1 is then available to absorb heat from the exhausting air passing through the flue duct 18'.

In an alternative embodiment, the valve switching may be linked to heat-sensing means 40 disposed in the receiving duct 5 rather than the heat-sensing means 21 disposed in the exhaust duct 11. In this embodiment, the signal is received and

amplified by amplifier 41 and received by threshold 23, which in turn activates the valve-switching means 24 and 25 as before.

In still a further embodiment, both heat-sensing means 21 and 40 may be disposed as shown in FIGS. 1 and 2, or elsewhere as convenient, with the provision that either may override the other by means of a comparison signal detector in threshold switch 23. Thus, if the air exhausting through duct 11 becomes too hot by virtue of the fact that the checker-box C-2 is no longer accepting heat from the air developed in chamber 7, it can cause the assembly to switch to the cooler checker-box C-1. If at the same time, the air passing through the receiving duct 5 becomes too cold for efficient operation of the burner by virtue of little air preheating, the signal from sensor 40 can override that being received from sensor 21 in the event the signal from 21 has not yet reached the threshold preset in threshold switch 23. In this event, a minimum temperature threshold limit set in threshold switch 23 with respect to the signal from sensor 40 would override any signal received from the sensor 21 and cause the valve-switching means 24 and 25 to actuate to complete the second half of the cycle. The upper limit signal from sensor 21 will usually govern in cases where there is a high heat output in chamber 7 as for example in an oven during broiling or heat cleaning, or an incinerator in full operation, whereas the lower limit signal from sensor 40 would govern in cases where the heat output is low in chamber 7, for example low temperature baking in an oven or ordinary range top operation in the case of a smooth top range. It should be understood that the heat sensors may be placed in other ducts, or directly within the chamber 7, or in a plenum which may be in communication with the burner 12, as the case may be. Likewise, it should be understood that any type of valve-switching means may be used with the valves. For example, the valves may be mounted on pins and actuated in a rotational fashion. Likewise, it should be understood that the valves may be mechanically and nonelectrically actuated, as for example a bimetallic, spring-biased valve actuator of standard construction, with the bimetal sensor disposed in the ducting adjacent to the valve in question.

In addition, the fans and valves may be linked to flame and airflow sensors, and to door-latching mechanisms to insure safety of operation. Thus, for example, upon initial ignition of the flame, the fan 19 would not start until flame sensor has indicated full operation of burner 12. Likewise, an airflow sensor, such as a sail switch, may be linked to the gas supply and burner 12, 13 so that in the event of failure of the fan 19, the burner would shut off thus preventing over heating of the exhaust checker-box.

It should also be understood that the arrangement of the inlet ducting 15 and exhaust ducting 11 may be reversed or otherwise arranged to suit the convenience of the particular appliance. As shown in FIGS. 1 and 2, the exhaust ducting is interior of the intake ducting thus providing for additional heat exchange surfaces for further preheating of the ambient air and cooling of the exhaust air. Likewise, additional fans may be disposed in the inlet ducts 15, 15' to provide for sufficient airflow, or the exhaust fan 19 may be eliminated entirely so that the air may be forced in rather than the airflow being by means of draft in the case of the use of fan 19 alone.

Referring now to FIG. 3, this FIG. shows in perspective the improved checker-box of this invention applied to a home incinerator of the type shown in our copending application Ser. No. 670,908. In this embodiment, the inlet duct 15 is shown in the center with the input air being preheated in the left hand checker-box C-1. After the air is preheated in checker-box C-1, it passes into inlet duct 5 which is formed by valve G being closed off from the afterburner chamber 42 so that the preheated air, PA passes into the primary combustion chamber 43 via duct 44 and apertures 45. In operation, the garbage to be incinerated is placed in the primary combustion chamber 43 through door 46, and the burner 12 near the grill-work floor 47 is ignited to start the refuse burning. After the refuse has commenced burning and can support its own com-

bustion, the burner 12 is turned off, or turned back to a pilot level. The smoke and gases pass beneath baffle 48 into the afterburner chamber wherein the afterburner 49, having fuel supply line 50, produces a flame impinging upon a target plate 51 which adequately incinerates the odors and smoke to produce a substantially clean flue gas. The flue gas passes upwardly in the afterburner chamber through the receiving duct 52 and into checker-box C-2 wherein it gives up its heat. Thereafter, the valve F being open, a fan permits the cooled exhaust gases to be exhausted out the exhaust duct 11. As can be seen, the valve H is in the vertical position thus blocking off the heated air from the afterburner receiving duct 52 from passing back into the duct 44.

When the checker-box C-2 reaches its switching temperature, the valve D opens, as shown by the arrow of rotation R, to provide the exhaust path through duct 11'; valve E is switched, shown by rotation arrow S, to divert the incoming air to checker-box C-2; and valve F is closed as shown by rotation arrow T to close off the exhaust duct 11. Simultaneously, the valve G is raised from the horizontal to the vertical position thus opening a passage from the afterburner chamber through the duct 5 into checker-box C-1 and out the exhaust duct 11'. The rotation of this valve is shown by the rotation arrow U. Likewise, and simultaneous with the rotation of valve G, the valve H is dropped from its vertical position to a horizontal position as shown by the rotation arrow V. This in turn permits the air coming in through the inlet duct 15 to pass through checker-box C-2, the receiving duct 52, and thence into the duct 44, through apertures 45, and into the primary chamber 43. As before, these valves may be linked to heat sensors disposed in the ducts 11, 11', 15, 44, 52 or 5 and actuated by electromechanical solenoids, or by bimetallic coils attached to the pivot rods of the damper-type valves or flaps. By such means, the temperature in the exhaust ducts 11 or 11' may be kept below a preselected maximum temperature, for example, 200° F. for exhausting directly to the room in which the appliance is located.

In another alternative embodiment, a dilution air inlet controlled by a bimetallic damper may duct air directly to the receiving duct 5 (FIG. 1), or to the exhaust duct 11 of FIGS. 1 and 2 and 11' of FIG. 1. By this means, added air may be directly inlet to either side of the checker-boxes to assist in the temperature control.

In an alternate embodiment the threshold switch 23 contains a timer device, and the heat sensors 21, 40 and amplifiers 22, 41 may be eliminated. The timer actuates switching means 24, 25 in accordance with a preset cycle to switch the valves A-B-C and M-N-O for the complete regenerator cycle. This embodiment is particularly useful in domestic appliances of relatively standard heat load with the fan speed and volumetric draw rate, in c.f.m., being preset. The louvre apertures can also be preset for such standard loads, thus providing for simple, factory assembly setting. Likewise, the duct sizes may be predetermined for standardized load characteristics.

The checker-box may contain staggered rows of firebrick. Gases flow through the openings formed in successive rows of firebrick in intimate contact with the bricks. Hot gases from the appliance heat the bricks and the gases are in turn cooled until the valving switches for the second half of the cycle. Then cool ambient air passes over the hot bricks and is thereby preheated while the bricks are cooled. The bricks may be arranged in any geometric form and enclosed in any convenient housing, e.g. cylindrical or cubic.

Where an exterior exhaust vent is employed, the amount of insulation needed is negligible since the exhaust gases are relatively cool. This low exhaust gases temperature permits a significant reduction in the clearance presently required between flue ducting and combustibles, thus permitting installation of an appliance of our invention in places where conventional units would not fit. The insulation may be an airgap, and a preferred type employs a concentric pair of ducts, one being placed interiorly of the other. The central duct serves as the exhaust duct while the annular space between the inner and

outer ducts serves as the incoming air duct. Some small additional degree of preheating incoming air while further cooling exhaust gases is obtained by this construction.

It should be appreciated that for the domestic appliances all airflow rates may be preset, and the gas flow and airflow rates are constant during the period the appliance is in use. The exhaust temperature is kept below a predetermined maximum by the air and gas input rates and the capacity and switching time of the regenerator, which can be varied by size.

Those skilled in the art will recognize that the only limitation to the particular checker-boxes used is that the size must be proper to effect the desired cooling function and still be practical for incorporation within the incinerator unit, whether used for domestic or commercial purposes. Having described our invention, those skilled in the art will recognize that various modifications can be made thereto within the spirit of the invention, which we intend to be limited solely by the following claims.

we claim:

1. In a gas-fired appliance including a heating chamber, a fuel gas burner in association with said chamber to heat material therein, duct means which include at least two ducts for supplying incoming and exhausting air, and means for circulating said incoming and exhausting air, the improvement which comprises in combination:

means for preheating incoming air and cooling exhaust air from said appliance disposed in communication with the incoming and exhausting air ducts, and

means for regulation of direction of circulation of said air through said ducts disposed in association therewith, said regulation means alternately permitting said ducts to operate as either incoming or exhaust ducts.

2. An improved appliance as in claim 1 wherein said means for preheating incoming air and cooling exhaust air includes a first and a second checker-box containing heat-resistant and substantially nonthermal conductive materials, said first checker-box being disposed in communication with one of said ducts to alternately heat and cool said incoming and exhaust air respectively as said air direction changes in response to said regulation means,

said second checker-box being disposed in another of said ducts to alternately cool and heat said exhausting and incoming air respectively in response to said regulation means and being in functional mode opposite said first checker-box,

said regulation means including means for controlling said alternating flow of incoming and exhaust gases to pass through said checker-boxes in a cycle and maintaining the exhaust gases temperature below a predetermined maximum.

3. An improved appliance as in claim 2 wherein said regulation means includes duct means disposed between said checker-boxes and said heating chamber, and contains means for diverting air into and out of said chamber in unison with regulation of air incoming and exhausting from said checker-boxes.

4. An improved appliance as in claim 3 wherein said means for regulation includes means for alternately switching air between said incoming air and exhaust ducts to said first and second checker-boxes respectively.

5. An improved appliance as in claim 4 wherein said regulation means includes means for sensing heat disposed in said exhaust duct and operative to actuate said switching means in response to a preset level of heat in said exhaust duct.

6. An improved appliance as in claim 5 wherein said switching means includes valves comprising pivoted baffles operated in unison.

7. An improved appliance as in claim 3 wherein said regulation duct means includes a duct for receiving preheated air from said first checker-box for delivery to said chamber and said burner, and at least one duct for passing flue gas from said burner to said second checker-box, said flue gas duct being closeable by a valve pivotable between a first and second posi-

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tion, and said receiving duct alternately communicating with said checkerboxes by a valve pivotable between a first position providing passage from said first checker-box to a second position providing passage from said second checker-box.

8. An improved appliance as in claim 1 wherein said chamber is an oven cooking chamber.

9. An improved appliance as in claim 1 wherein said chamber is an incinerator chamber.

10. An improved appliance as in claim 1 wherein said chamber is a heating chamber disposed beneath a smooth top range heating surface.

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