United States Patent [19]

Jensen

[11] **3,799,142**

[45] **Mar. 26, 1974**

[54] **METHOD AND APPARATUS FOR SEQUESTERING OPEN FLAME COMBUSTION GAS**

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[21] Appl. No.: **247,722**

[52] **U.S. Cl.** ..... **126/39 J,** 126/39 R, 126/92 RC, 431/329

[51] **Int. Cl.** **F24c 3/00**

[58] **Field of Search** ..... 126/39 J, 39 H, 39 R; 431/20; 236/96

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Primary Examiner—William E. Wayner
Assistant Examiner—W. E. Tapolcai, Jr.
Attorney, Agent, or Firm—Robert W. Beach

[57] **ABSTRACT**

Combustion gas channelled to flow alongside a surface of an open burner, such as over the usually upright catalytic bed of a space heater, or a generally horizontal stove cooking top or pot bottom overlying the open burner, is segregated by an aperture in the path of flow of the combustion gas, so that the gas flows through such aperture, instead of being dissipated into a room space and mixed with the ambient gases of the space. The effluent combustion gas thus sequestered is withdrawn by suction through a discharge duct. The opening through such aperture or discharge duct can be regulated by a shutter or damper, which can be adjusted by temperature-responsive thermostatic means, responsive to the temperature of combustion gas flowing through the segregating aperture or discharge duct, to enlarge the opening as the temperature rises and to restrict the opening as the temperature decreases.

5 Claims, 13 Drawing Figures

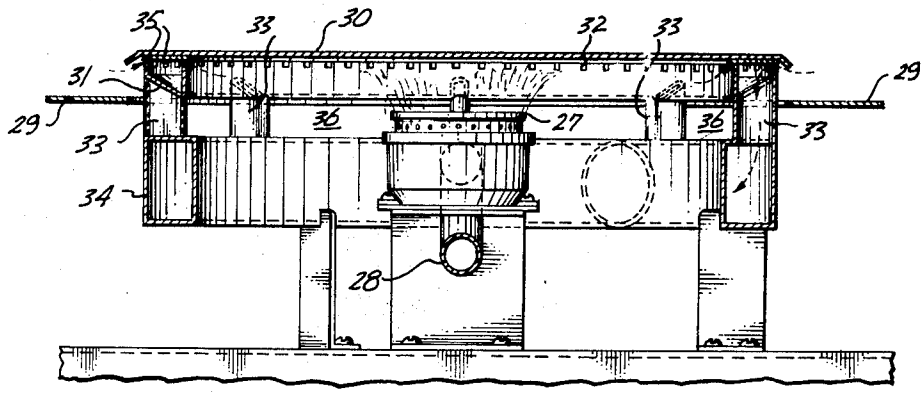


Fig. 1.

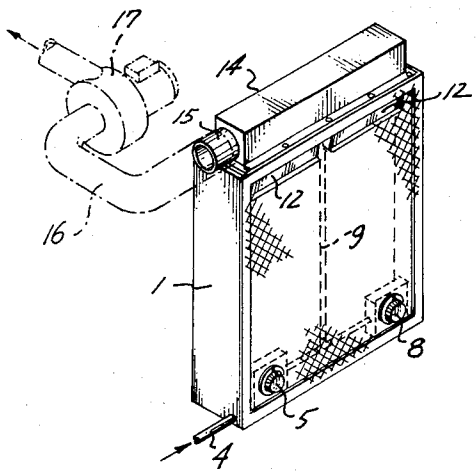


Fig. 4.

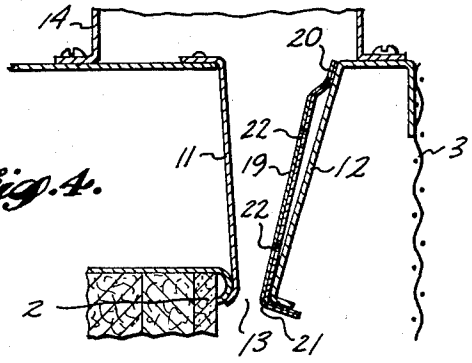


Fig. 5.

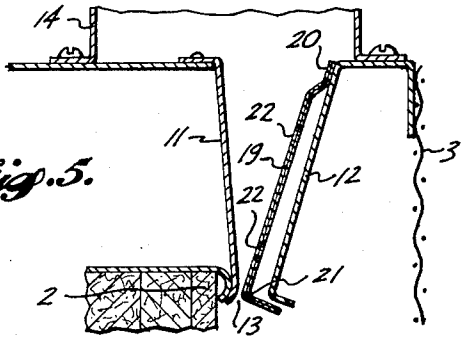


Fig. 2.

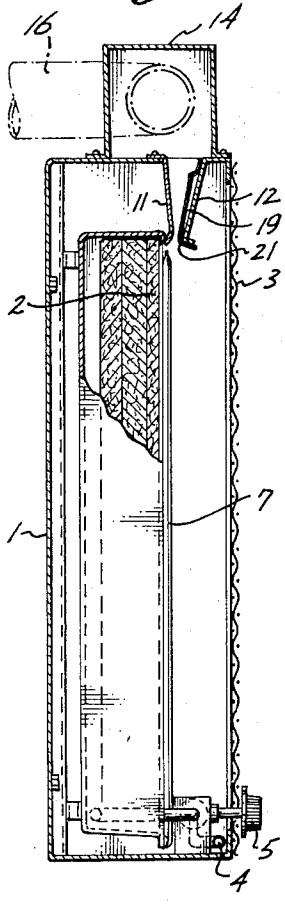


Fig. 3.

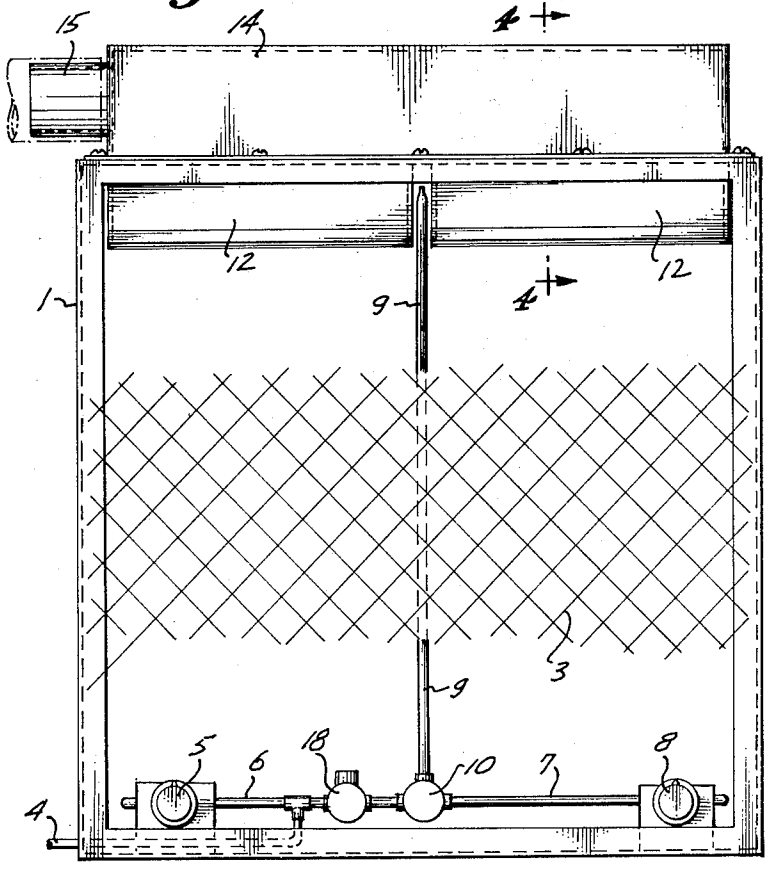


Fig. 9.

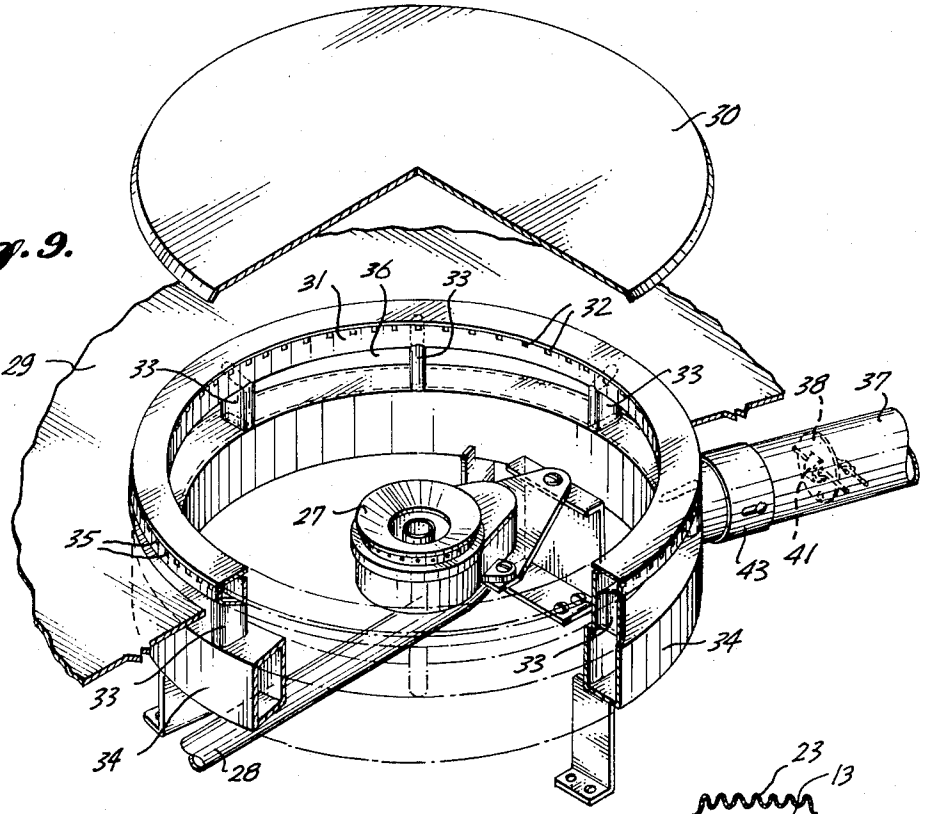


Fig. 6.

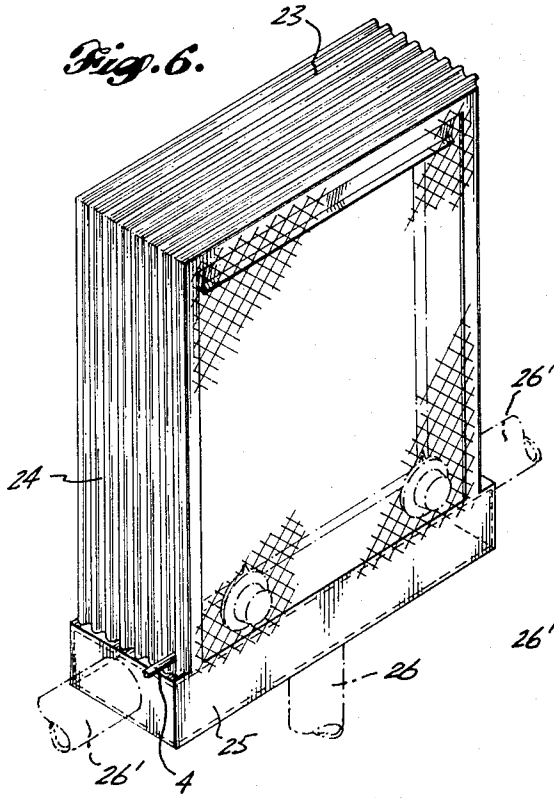
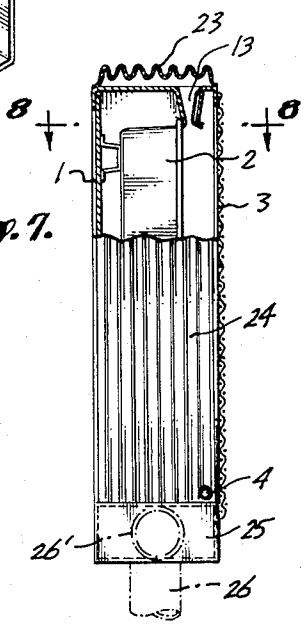


Fig. 7.



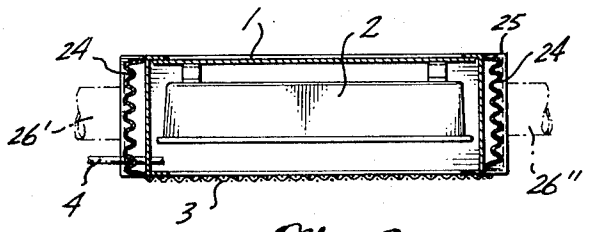


Fig. 8.

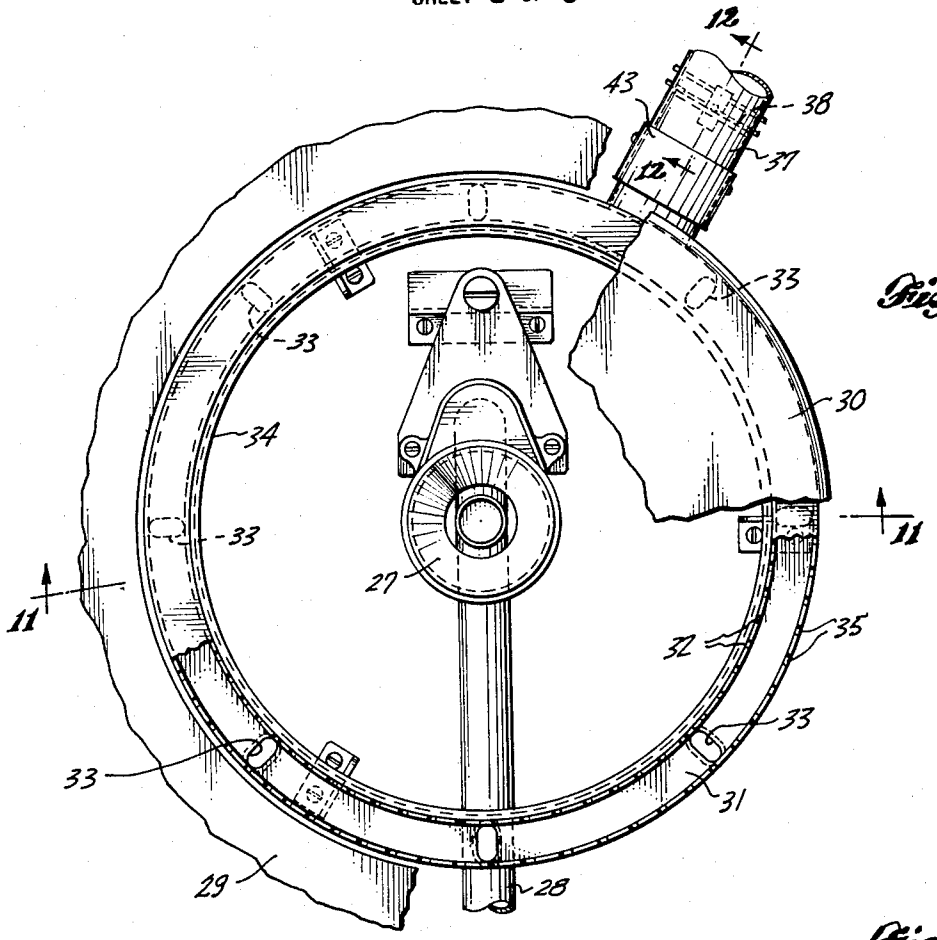
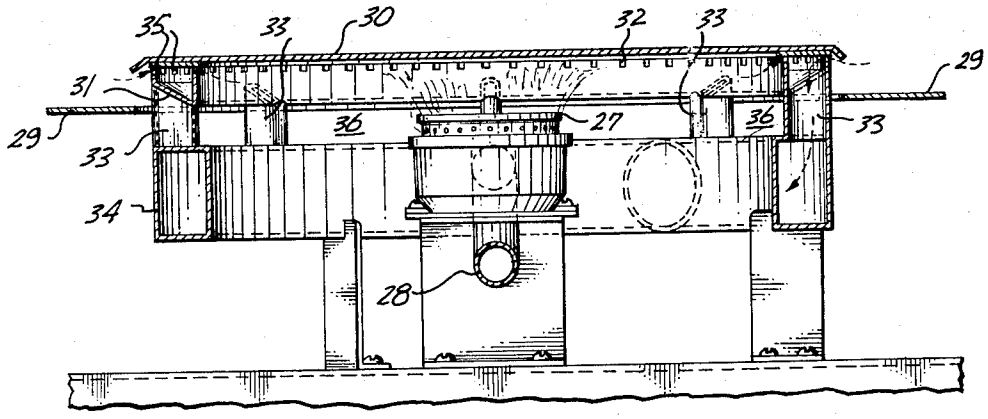


Fig. 10.

Fig. 11.



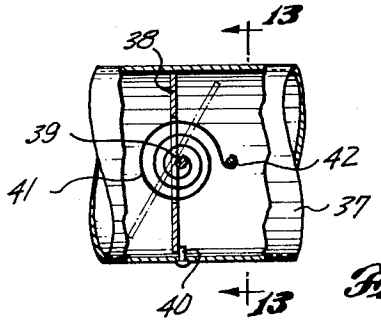


Fig. 12.

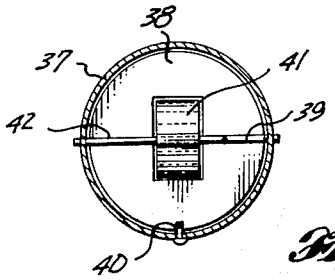


Fig. 13.

METHOD AND APPARATUS FOR SEQUESTERING OPEN FLAME COMBUSTION GAS

The method and apparatus of the present invention is concerned with segregating combustion gas from and avoiding oxygen depletion in a space affected by an open burner either to warm the space or for cooking purposes.

A catalytic bed heater using either combustible gas, such as butane or propane, or a gas-forming liquid hydrocarbon, such as gasoline, or some other liquid which forms a combustible gas, such as methyl alcohol, provides a compact, convenient and attractive space heater. Three principal difficulties have been experienced with such heaters, namely, the production of excessive condensation in the space being heated, the depletion of oxygen from such space, which oxygen is used to support the combustion of such heater, and the accompanying accumulation of products of combustion in such space, which may include noxious gases.

Gas burners are also used conveniently for cooking purposes; but such use has the same disadvantages as mentioned above in connection with burning combustible gas in a space heater and, in addition, produces waste heat by heating locally the space in which the burner is located, which may be undesirable, especially in the summer.

Gas, gasoline or alcohol space heaters or cooking stoves customarily are used in confined spaces, such as in a boat cabin, in a house trailer, or in a camper. Because the volume of such spaces is comparatively small and such vehicles usually have rather large windows, annoying condensation of water vapor on cold surfaces occurs. Moreover, replacement of air in such a space with outside air is quite limited. Since the products of combustion of such gas, hydrocarbon liquid, or alcohol are principally water and carbon dioxide, condensation necessarily follows after a condition of maximum humidity has been reached. Also, in such confined space, oxygen depletion from the air to support combustion of the gas is very significant. Moreover, as the oxygen is depleted from the air, not only is there less oxygen available for occupants of the space to breathe, but the products of combustion will tend to include an increased amount of carbon monoxide, which is noxious, instead of carbon dioxide.

A principal object of the present invention, therefore, is to sequester effectively a substantial proportion, and preferably a principal proportion, of substantially smokeless combustion gas formed by the combustion of an open burner from a confined space in which the burner is located. A companion object is, by such segregation of products of combustion, to enable admission of outside air otherwise excluded when combustion gases are not sequestered. The effect of such combustion gas sequestration is to eliminate condensation within the space in which the burner is located, to reduce drastically the combustion products in the air of such space, and to improve ventilation of the space.

Another object is to remove substantially smokeless effluent combustion gases from the space in which a burner is located with minimum reduction in the efficiency of combustion and space heating or cooking effectiveness.

It is also an object to sequester effluent combustion gas produced by a burner with apparatus of simple and economical construction, which is easy to install and maintain.

FIG. 1 is a top perspective of a catalytic space heater incorporating the invention;

FIG. 2 is a vertical section through such space heater with additional parts broken away, and

FIG. 3 is a front elevation of such heater with parts broken away.

FIG. 4 is a detail, fragmentary vertical section through a portion of the heater taken on line 4—4 of FIG. 3, and

FIG. 5 is a similar view, showing a component in a different operative position.

FIG. 6 is a top perspective of a somewhat modified type of space heater;

FIG. 7 is an edge elevation of such heater, with parts broken away, and

FIG. 8 is a horizontal section through the space heater taken on line 8—8 of FIG. 7.

FIG. 9 is a top perspective of a gas cooking burner to which the present invention is applied, a part being shown in exploded relationship, and parts being broken away.

FIG. 10 is a plan of such cooking burner having parts broken away, and

FIG. 11 is a vertical section through such burner taken on line 11—11 of FIG. 10.

FIG. 12 is an enlarged detail section through the discharge duct of the apparatus, taken on line 12—12 of FIG. 10.

FIG. 13 is an enlarged detail section taken on line 13—13 of FIG. 12.

The most important utilization of the present invention is in connection with a conventional open burner an example of which is a gas space heater, such as shown in FIG. 1. Such a heater includes a casing 1 housing the catalytic bed 2, which may be of asbestos or other heat-resistant inert mineral, to which catalytic bed a very thin coating of platinum group metal has been applied to serve as a catalyst. Use of such a catalyst enables gas supplied to the catalytic bed to burn at the radiating face of the bed at a lower temperature than would otherwise be required for combustion of the gas. The heat of the burning gas is radiated through the grill 3, and, normally, the substantially smokeless gaseous products of combustion also pass through such grill and are dissipated in the lining space in which the heater is located.

The catalytic bed space heater shown in FIGS. 1, 2 and 3 of the drawings is typical and representative of such conventional space heaters, except for the application of the present invention to such heater. Conventional features of such a heater include the gas supply pipe 4 connected to a starting valve 5 by conduit 6, which valve can be opened to provide a larger supply of gas to the catalytic bed for starting purposes than would be required under normal operating conditions. Another branch 7 of the gas supply line 4 supplies gas to the heat intensity control valve 8, which is manually controlled for low, medium and high heat. A temperature-responsive tube 9 controls a safety shutoff valve 10 arranged in the conduit 7 leading from the gas supply pipe 4 to the control valve 8.

The normal catalytic bed space heater described radiates heat from the bed 2 into the room, and the hot combustion gas also is allowed to escape into the room because it is substantially smokeless. While such com-

bustion gas supplies additional heat to the space being heated, it also produces condensation, depletion of oxygen, and perhaps noxious gas, such as carbon monoxide, to a greater or lesser extent. The function of the present invention is to segregate the combustion gas and lead it off to some location other than the space being heated by the space heater. By burning the gas at the face of the catalytic bed **2**, the heat of the burning gas produces a convection current of combustion gas rising across the face of the catalytic bed as a substantially laminar flow. The flow of combustion gas thus channelled can be segregated at the upper portion of the catalytic bed from the space to be heated and led out of the heater to another location, such as open atmosphere, instead of being dispersed into such space.

A construction effective to segregate combustion gas channelled upward over the face of the catalytic bed **2** includes an inner wall **11** and and outer wall **12** having their lower adjacent edges spaced apart to form an effluent combustion gas collector passage or slot **13** which is closed at its ends. This slot provides communication between the interior of the heater casing **1** and a plenum chamber **14** extending across the top of such casing, as shown in FIGS. **2** and **3.** From this plenum chamber, the effluent combustion gas is discharged through the outlet **15** and discharge duct **16** to the external atmosphere, or some other disposal location. The combustion gas is drawn from the plenum chamber through the duct **16** by suction produced by the exhaust fan or blower **17** or by wind-induced draft or by natural convection.

Particularly if considerable reliance is placed on an exhaust fan to lead off the combustion gas from the heater casing, it is desirable to provide suitable safety shutoff controls for the segregating and suction mechanism. One such control may be a solenoid valve **18** provided between the gas supply pipe **4** and the connection **7** to the control valve **8.** If the exhaust fan or blower **17** should become inoperative, or if the voltage of the current source for the fan-operating motor or the speed of the motor or the draft provided by the fan should be reduced below a predetermined value, the solenoid valve **18** can shut off completely the supply of fuel to the catalytic bed. Alternatively, a voltage-sensitive relay could be employed, both to deenergize the fan motor and to effect closure of the solenoid valve **18** if the supply voltage to the motor decreases below a predetermined value.

If the flow of effluent gas induced into the slot **13** by the exhaust draft were sufficiently strong, air might be drawn from the space to be heated through the grill **3** and into the slot **13,** in addition to the effluent combustion gas. Under these circumstances, heated air from the room would be needlessly wasted. To foreclose any such possibility, the area of the opening into the gas-collector passage **13** could be altered, as might be required, so that substantially only the channelled flow of combustion gas would flow into the collector passage without any appreciable additional air. However, it is important that the area of the opening into the collector passage be sufficiently great so that as much as possible of the combustion gas would be segregated and pass into the gas collector passage.

The temperature of the effluent combustion gas passing through the slot **13** decreases with increase of flow, and, conversely, increases with decrease of flow as a function of mixing of ambient air of the space being heated. It is therefore desirable to control the area of the opening into the combustion gas collector passage in accordance with the temperature of such combustion gas. FIG. **4** shows the opening into slot **13** between walls **11** and **12** as being relatively wide, as compared to the width of such slot in FIG. **5.** The width of the slot opening shown in FIG. **4** would be appropriate for a condition in which the combustion gas was relatively hot, whereas the width of the opening shown in FIG. **5** would be appropriate when the combustion gas was relatively cool.

Alteration in the width of the opening into slot **13** can be effected by mounting in the slot a damper **19** for restricting such opening. Such damper can be of a length substantially equal to the full width of the catalytic bed **2,** and the upper edge **20** of such damper can be secured to the upper portion of the outer slot wall **12.** The lower portion of such damper may be formed with a stiffening flange together forming a flow-controlling lip **21,** which lip can be moved closer to or farther from the inner slot wall **11.** Movement of such flow-controlling lip in response to the temperature of effluent combustion gas flowing through the slot **13** can be effected by making the damper **13** of thermo-responsive bimetallic character, or providing a bimetal unit connected to effect swinging of the damper. Equalization of pressure on opposite sides of the damper plate can be effected by providing apertures **22** in the damper plate.

When the heat intensity control valve **8** is adjusted for a low flame condition, the temperature of the combination gas passing through the opening to slot **13** will be relatively low, so that the flow-controlling lip **21** of the damper **19** will be located close to the wall **11,** as shown in FIG. **5,** to restrict the opening into the flow-segregating slot, so as to reduce the quantity of effluent combustion gas flowing into the gas-collector passage.

On the other hand, if control valve **8** is turned to the high range to supply more combustible gas to the catalytic bed **2,** the temperature of the effluent combustion gas passing into the collector passage **13** will be higher, which will activate the temperature-responsive means controlling the position of damper **19** to open the damper toward the position of FIG. **4.** The opening into the gas-collector slot **12** will therefore be enlarged generally commensurate with the larger volume of the channelled flow containing the combustion gas produced, so that, again at least most of the flow channelled upwardly over the face of the catalytic bed **2** will be segregated by passage through the slot **13** in its flow path and led away from the space being heated through the discharge duct **16** instead of escaping into the space being heated.

The heat resulting from the burning of the combustible gas at the surface of the catalytic bed **2** is of two types: first, the radiant heat projected from the catalytic bed into the space to be heated, and, second, the heat of the combustion gas. The quantity of heat of the first type is much greater than the quantity of heat of the second type. As has been mentioned above, the effect of the catalytic bed **2** is to enable the combustible gas to burn at the surface of the catalytic bed at a temperature considerably lower than the normal ignition temperature of the combustible gas. If the resulting combustion gas is sequestered from the heater casing

1 and exhausted, as described above, that portion of the heat resulting from the combustion which is retained in the effluent combustion gas will be wasted. While this proportion of the combustion heat is minor, it may be desirable to conserve at least some of such heat without the disadvantages of moisture condensation on surfaces in the space being heated, depletion of oxygen in such space, and contamination of such space by noxious components of the combustion gas.

FIGS. 6, 7 and 8 illustrate a catalytic bed space heater of the same type as shown and described in connection with FIGS. 1 to 5, inclusive, except that this heater has a heat exchanger for the purpose of salvaging heat from the sequestered effluent combustion gas. While various types of heat exchanger constructions could be used, FIGS. 6, 7 and 8, show a corrugated top heat exchange surface 23, and side heat exchange surfaces 24 spaced outwardly from the top and sides, respectively, of the heater casing 1 to provide a passage for effluent combustion gas.

The gas-collector passage of slot 13 provides a passage between the interior of the heater adjacent to the catalytic bed 2 and the space between the top of the heater casing 1 and the jacket top 23, as shown in FIG. 7. The opposite ends of such space are in communication with the upper ends of the spaces at opposite sides of the heater between the heat exchanger jacket sides 24 and the sides of the heater casing 1. The lower ends of the side passages open into a plenum chamber 25 beneath the heater. An effluent combustion gas discharge duct can be connected to the plenum chamber at any location, such as the duct 26 connected to the bottom of the plenum chamber, the duct 26′ connected to one end of the plenum chamber, or the duct 26″ connected to the other end of the plenum chamber.

In a heater having a heat exchanger, such as of the type shown in FIGS. 6, 7 and 8, it is more important that an exhaust fan or blower be connected to the discharge duct, as indicated in FIG. 1, to provide an exhaust draft for insuring that the combustion gas flows through the collector passage 13, and the heat exchanger passage, instead of being discharged into the space being heated. The amount of heat extracted from the effluent combustion gas passing through the heat exchanger passage, and conducted through the walls 23 and 24, will, of course, radiate to the space being heated and supplement the heat produced by direct radiation from the combustion of the gas at the surface of the catalytic bed.

Another type of open burner to which the present invention is applicable is a surface cooking unit. FIGS. 9, 10 and 11 show a conventional gas burner 27 supplied with gas through a conduit 28. This burner is suitably supported concentrically within a circular aperture in a cooking stove top 29. A circular lid 30, which may be imperforate, is provided for the burner, which should be mounted on structure sufficiently strong so that the plate will support the heaviest type of cooking pot and contents which could be placed on it.

The supporting structure for the lid 30 illustrated includes a plenum chamber in the form of an upper tubular ring 31 having gas-collecting passages 32 around the upper portion of its inner periphery in the form of a circumferentially spaced slots. Such gas-collecting ring is supported by circumferentially-spaced tubular posts 33 upstanding from a tubular plenum chamber 34. Such tubular posts provide passages for effluent combustion gas from the collector ring 31 down into the plenum chamber ring 34.

The burner lid 30 is preferably of metal, which will not be damaged by flames from the burner 27 playing on it. If such lid is imperforate, or if any apertures in it are covered by the bottom of a pot set on the upper surface of the lid, such lid alone or supplemented by the pot bottom, will form a surface toward which the flames of the burner 27 are projected, and toward which convection currents of air to support combustion flow upward alongside the burner. Because the lid 30 alone or supplemented by a pot bottom is imperforate, the hot combustion gas cannot rise directly upward, as it tends to do. Instead, the hot combustion gas will be forced radially outward in all directions from the burner 27 by additional combustion gas being formed continually by the operation of the burner 27.

Since the convection flow of the combustion gas is blocked by the burner lid 30, the combustion gas will be channelled radially outward in all directions in a thin layer beneath the lid. The collecting passages 32 in the tubular ring 31 are thus located in the path of such channelled flow of combustion gas to segregate such flow and confine the effluent combustion gases in the hollow ring. The temperature of such effluent combustion gas is much hotter than that of combustion gas formed by combustible gas burning alongside a catalytic bed. Consequently, it is desirable to reduce the temperature of such effluent combustion gas within ring 31 by air bled into ring through apertures 35 in the outer periphery of the ring.

By spacing the gas-collector ring 31 from the annular plenum chamber 34 by posts 33, circumferentially spaced openings 36 are provided between the posts for flow of pressure-balancing air into the space bounded by the hollow ring 31. This balancing flow of air may be partly required to support combustion in the event that there is not sufficient flow of air to the burner from under circular plenum chamber 34. But, in any event, these spaced openings 36 will insure normal operation of burner 27.

Effluent combustion gas from burner 27 passing into the interior of collector ring 31 and down through posts 33 into the annular plenum chamber 34, mixed with air entering the ring 31 through slots 35, is exhausted to the atmosphere or to some space other than the space in which the cooking burner is located. Flow of the effluent combustion gas thus led off from the collector ring 31 and the plenum chamber 34 is facilitated by providing an exhaust draft in the discharge duct 37, connected to one side of the plenum chamber. Such exhaust draft may be produced by connecting in such discharge duct an exhaust fan or blower corresponding to the fan 17 shown in FIG. 1.

For any given size of flame from burner 27, the temperature of the effluent combustion gas-ambient air mixture will increase with decreased flow of these gases and, conversely, the temperature of the mixture will decrease with increased flow. It is desirable to sequester substantially all of the combustion gas produced. Since the temperature of such combustion gas is generally inversely proportional to the flow rate of the combustion gas, the flow of effluent combustion gas into the collector ring 31 through the tubular posts 33 and the planum chamber 34 can be regulated by varying the opening through the discharge duct 37, or the intensity of the exhaust draft, or both. FIGS. 9, 10, 12 and 13 show a

damper for restricting the opening through the discharge duct **37.**

The damper **38** is shown as being of the butterfly valve type pivotally mounted by shaft **39** extending diametrally through the duct **37.** Swinging of this valve in closed position is limited by a stop pin **40** engageable by the edge of the damper, as shown in FIGS. **12** and **13.** To vary the degree of opening of the damper automatically in response to the temperature of the effluent combustion gas flowing through the duct **37,** a spiral temperature-responsive bimetallic coil is received in an aperture in the center of the damper **38,** and has its inner end connected to the damper shaft **39** or to the damper itself, and its outer end connected to an anchor rod **42,** extending diametrally through the duct **37** spaced longitudinally of it from the damper shaft **39,** as shown in FIG. **12.**

When the burner **27** is not operating, the bimetallic spiral **41** will hold the damper **38** in the closed position shown in solid lines in FIG. **12,** so as to avoid any undesirable communication between outdoors and the space in which the burner is located. When the burner is lit, the heated effluent combustion gas will cause the bimetallic spiral to uncoil, which will open the damper progressively, such as indicated by broken lines in FIG. **12,** in accordance with the temperature of the effluent combustion gas flowing through duct **37.** Because the area of the damper is balanced around the shaft **39,** the exhaust draft will not tend to alter the adjusted position of the damper appreciably.

Provision of the apparatus for sequestering the combustion gas produced by burner **27** in the manner described not only deters condensation on surfaces in the space in which the burner is located, and eliminates the dissipation of noxious gases from the combustion into such space, but also removes from the space in which the burner is located the heat of the combustion gas, which otherwise would effect an increase in the temperature of the cooking area. Ordinarily, such heating of the cooking area atmosphere is undesirable.

I claim:

1. Apparatus for sequestering combustion gas from a burner in a living space, comprising a generally horizontal surface beneath which the burner occurs, means supplying combustible gas for burning for flow of substantially smokeless combustion gas closely adjacent to said surface, a tubular ring remote from and encircling said combustible gas-supplying means having an apertured inner periphery located adjacent to said surface for receiving combustion gas, said surface guiding the flow of the combustion gas along said surface toward said apertured inner ring periphery, and effluent combustion gas confining means leading from said tubular ring for flow of effluent combustion gas therethrough to a location separated from the living space in which the burner is located, said tubular ring having an apertured outer periphery for flow therethrough of air to be mixed in said ring with combustion gas entering said ring through its apertured inner periphery.

2. Apparatus for sequestering combustion gas from a burner in a living space, comprising a generally horizontal surface beneath which the burning occurs, means supplying combustible gas for burning for flow of substantially smokeless combustion gas closely adjacent to said surface, an upper tubular ring remote from and encircling said combustible gas supplying means and having an apertured inner periphery located closely adjacent to said surface for receiving combustion gas, said surface guiding combustion gas along said surface towards said apertured inner ring periphery, a lower tubular ring, and tubular posts spaced circumferentially of said rings, connected between said upper tubular ring and said lower tubular ring and affording communication therebetween, said posts definings openings therebetween for communication between the space outward of said tubular rings and the burner encircled by said upper tubular ring.

3. Apparatus for sequestering combustion gas from a burner in a living space, comprising a surface, means supplying combustible gas for burning for flow of substantially smokeless combustion gas closely adjacent to said surface, effluent combustion gas confining means for flow of effluent combustion gas therethrough to a location separated from the living space in which the burner is located and including a plenum chamber having a first aperture in a wall thereof, remote from said combustible gas-supplying means and located adjacent to said surface, said surface guiding the flow of combustion gas along said surface toward said first aperture, and said plenum chamber having a second aperture in a wall thereof near said first aperture for supplying air to said plenum chamber to mix with effluent combustion gas adjacent to said first aperture for cooling such gas.

4. The apparatus defined in claim **3,** in which the surface is a generally horizontal surface beneath which the burning occurs, and the confining means is annular and encircles the burner, the first aperture opens generally horizontally and the confining means are apertured substantially equally around their full circumference.

5. Apparatus for sequestering combustion gas from a burner in a living space, comprising a burner for producing substantially smokeless combustion gas, a generally horizontal surface above said burner, means for effecting flow of a layer of such combustion as alongside said surface, and effluent combustion gas confining means for flow of effluent combustion gas therethrough to a location separated from the living space in which the burner is located, including an upper tubular ring located adjacent to said surface and having an aperture therein, a lower tubular ring and tubular posts affording communication between said upper tubular ring and said lower tubular ring, said posts being spaced circumferentially of said confining means for flow of air therebetween to said burner encircled by said confining means, said surface guiding the flow of combustion gas alongside said surface toward said confining means for flow of combustion gas from such flow through said aperture.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,799,142 Dated March 26, 1974

Inventor(s) Fred H. Jensen

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 8, line 26, cancel the comma after "thereof"; line 45, change "as" to --gas--.

Signed and sealed this 13th day of August 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents