VENT SYSTEM FOR COOKING APPLIANCE

Inventors: Lawrence W. Hake, Destin, FL (US); John J. Hake, Edwardsville, IL (US)

Correspondence Address:
SENNIGER POWERS
ONE METROPOLITAN SQUARE, 16TH FLOOR
ST LOUIS, MO 63102

Assignee: DUKE MANUFACTURING CO., St. Louis, MO (US)

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ABSTRACT

A vent system for venting hot gas and effluents from a cooking appliance. The vent system includes a first direct vent structure having an inlet for receiving hot gas and effluents and an outlet communicating with atmosphere. The first direct vent structure defines a first flow path. At least one effluent-removal device is positioned in the first flow path for removing effluents from the hot gas. An atmospheric flue communicates with the outlet of the first direct vent structure for venting hot gas to atmosphere after it has passed through the effluent-removal device. A damper system and integrated control system are also disclosed.
FIG. 17
FIG. 21
VENT SYSTEM FOR COOKING APPLIANCE

BACKGROUND OF THE INVENTION

[0001] This application is a non-provisional of U.S. Provisional Patent Application Ser. No. 60/785,745, filed Mar. 24, 2006, the entirety of which is hereby incorporated by reference.

[0002] This invention relates generally to cooking systems, and more particularly to improved ventilation and energy management systems for cooking appliances such as cooking ovens (e.g., convection ovens, baking ovens and speed cooking ovens), rotisseries, broilers, solid fuel ovens, charbroilers, and fryers.

[0003] Cooking appliances used in commercial establishments (e.g., institutions, and family, casual, fine-dining, and fast-food restaurants) generate heat, combustion gases, cooking gases, and effluents such as grease, moisture and other particulates. Large overhead exhaust hoods and associated fans are often used to vent such cooking appliances, but these systems require substantial air flow and are not energy efficient. Further, substantial amounts of heat typically escape from the cooking appliance, resulting in further energy loss. There is a need, therefore, for an improved ventilation and energy management system for cooking appliances, particularly in view of increasing utility costs and anticipated stricter environmental regulations requiring reduced levels of cooking by-products discharged to atmosphere.

SUMMARY OF THE INVENTION

[0004] Among the several objectives of this invention may be noted the provision of an improved ventilation and energy management system for cooking appliances. In different embodiments, the system has one or more of the following advantages: flexibility and adaptability for integration with various types of cooking appliances; capture and disposition of hot gases and effluents in an energy efficient manner; adaptability to meet different effluent-removal requirements; integration of the system with the particulars of the cooking process; foods cooked and cooking appliance; reduced duct maintenance and cleaning requirements; an optional damper system for controlling flow through the system to increase effluent-removal efficiency and effectiveness, and to provide more efficient energy management; an optional integrated fan system for generating desired flow throughout the system; an optional recirculation system for re-circulating flow to improve effluent removal and energy management throughout the system and/or cooking appliance; an optional feature for controlling fans and/or other movable components of the vent system in response to sensing the presence or certain characteristics of the hot gas and effluents from the cooking appliance; and an optional embodiment where there is no need for exhausting hot gas to an atmospheric flue. It is anticipated that a system of this invention will contribute substantially to meeting the standards of an energy efficient or "green" restaurant, a goal which is becoming more and more important.

[0005] In general, a ventilation and energy management system of this invention has one or more unique features. In one embodiment, the system includes a direct exhaust vent adapted to be positioned adjacent the cooking appliance. The direct exhaust vent comprises a first direct vent structure having an inlet for receiving said hot gas and effluents and an outlet communicating with atmosphere. The first direct vent structure defines a first flow path from the inlet to the outlet for flow of hot gas and effluents along the flow path. At least one effluent-removal device is provided in the first flow path for removing effluents from the hot gas. The direct exhaust vent also includes an atmospheric flue communicating with the outlet of the first direct vent structure for venting hot gas to atmosphere after it has passed through the effluent-removal device.

[0006] In another embodiment, the vent system comprises an exhaust canopy for collecting hot gas and effluents from an environment surrounding the cooking appliance. The exhaust canopy has an exhaust duct and an exhaust fan for venting hot gas and effluents collected by the canopy. The system also includes a direct exhaust vent inside the exhaust canopy. The direct exhaust vent comprises a first direct vent structure defining a first flow path for directing hot gas and effluents exiting a cooking chamber of the cooking appliance, and an atmospheric flue communicating with the first flow path for venting hot gas to atmosphere.

[0007] In yet another embodiment, the vent system comprises an exhaust canopy for collecting hot gas and effluents from an environment surrounding a cooking appliance, and a direct exhaust vent inside the exhaust canopy. The direct exhaust vent has a first inlet for receiving hot gas and effluents exiting the cooking appliance, an outlet, and an atmospheric vent communicating with the outlet. The system also includes a fan box inside the exhaust canopy for directing hot gas collected by the exhaust canopy to a second inlet of the direct exhaust vent communicating with the atmospheric vent.

[0008] In another embodiment, the vent system is adapted for retrofit installation in an existing exhaust canopy for venting hot gas and effluents from a cooking appliance. The vent system comprises a housing adapted to be secured inside an existing exhaust canopy, and a direct exhaust vent inside the housing. The direct exhaust vent has a first inlet for receiving hot gas and effluents exiting an exhaust area of the cooking appliance, an outlet, and an atmospheric vent communicating with the outlet. The system also includes a fan box inside the housing for directing hot gas collected by the exhaust canopy to a second inlet of the direct exhaust vent communicating with the atmospheric vent.

[0009] In another embodiment, a vent system of this invention comprises a first direct vent structure defining a first flow path for venting hot gas and effluents from a first exhaust area of the cooking appliance, and a second direct vent structure defining a second flow path for venting hot gas and effluents from a second exhaust area of the cooking appliance. At least one atmospheric flue communicates with the first and second flow paths.

[0010] Another embodiment of this invention is directed to a method of venting hot gas and effluents from a cooking appliance of the type having a cooking chamber, a first exhaust area for exhausting hot gas and effluents from the cooking chamber, and a second exhaust area through which hot gas and effluents are exhausted from the cooking appliance into an environment surrounding the cooking appliance. The method comprises venting hot gas and effluents from the first exhaust area into a first direct vent structure defining a first flow path, and venting hot gas and effluents from the second exhaust area into a second direct vent structure at least partially defining a second flow path. The
method also includes the step of venting the hot gas flowing along the first and second flow paths into a common atmospheric flue.

[0011] In another embodiment, the present invention is directed to a damper system for adjusting flow from an exhaust outlet of a cooking appliance. The damper system comprises a damper housing adapted to be connected to the exhaust outlet and defining a flow path for exhaust from the exhaust outlet. A damper member is movable in the damper housing between an open position allowing flow along the flow path at a first flow rate and a closed position in which the damper member partially blocks the first flow path for flow at a second flow rate less than said first flow rate but greater than zero to allow venting of the cooking appliance while reducing heat loss from the cooking appliance.

[0012] The present invention is also directed to an integrated cooking and ventilation system. The system comprises a cooking appliance, and a vent system for ventilating hot gas and effluents from the cooking appliance. The vent system includes at least one movable venting component and at least one motor for moving the at least one venting component. An integrated control system is provided for controlling operation of the at least one motor and associated venting component as a function of the operation of the appliance.

[0013] In another embodiment, an integrated cooking and ventilation system of this invention comprises a cooking appliance, a vent system for venting hot gas and effluents from the cooking appliance, and an integrated control system for controlling operation of the vent system and the cooking appliance. The integrated control system is responsive to operation of the cooking appliance to vary flow characteristics of the vent system.

[0014] In another embodiment, the present invention is directed to a method of operating a cooking appliance and vent system for venting hot gas and effluents from the cooking appliance. The method comprises operating the cooking appliance, and varying the flow characteristics of the vent system as a function of the operation of the cooking appliance.

[0015] Other objectives, advantages and features of this invention will be in part apparent and in part pointed out hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 is a rear elevation of a direct vent system of this invention for venting cooking gas from a cooking appliance (shown in phantom);

[0017] FIG. 2 is a side elevation of the direct vent system and cooking appliance of FIG. 1;

[0018] FIG. 3 is a front elevation of a direct vent system in combination with a larger exhaust canopy;

[0019] FIG. 4 is a side elevation of FIG. 3;

[0020] FIG. 5 is a top plan view of FIG. 3;

[0021] FIG. 6 is a schematic view of a direct vent system of this invention inside a larger exhaust canopy with a filtered fan box;

[0022] FIG. 7 is a view similar to FIG. 6 showing another embodiment;

[0023] FIG. 8 is a top plan view of a vent system which combines a direct exhaust vent of this invention and a NFPA TYPE I exhaust hood or canopy;

[0024] FIG. 9 is a front elevation of the system of FIG. 8;

[0025] FIGS. 10 and 11 are views showing additional features of the system of FIGS. 8 and 9;

[0026] FIG. 12 is a vertical section showing an exemplary embodiment of a direct vent system of this invention positioned above a cooking appliance (in phantom);

[0027] FIG. 13 is a top plan view of FIG. 12;

[0028] FIG. 14 is vertical section showing another embodiment of a direct vent system of this invention positioned above a cooking appliance (in phantom);

[0029] FIG. 15 is a vertical section showing another embodiment of a direct vent system of this invention positioned above a cooking appliance (in phantom);

[0030] FIG. 16 is a vertical section showing another embodiment of a direct vent system of this invention positioned above a cooking appliance (in phantom);

[0031] FIG. 17 is a vertical section showing another embodiment of a direct vent system of this invention positioned above a cooking appliance (in phantom);

[0032] FIG. 18 is a vertical section showing another embodiment of a direct vent system of this invention positioned above a cooking appliance (in phantom);

[0033] FIG. 19 is a perspective of another embodiment of a direct vent system of this invention positioned above a cooking appliance;

[0034] FIG. 20 is a front elevation of the direct vent system of FIG. 19;

[0035] FIG. 21 is a vertical section in the plane of line 21-21 of FIG. 20;

[0036] FIG. 22 is a vertical section in the plane of line 22-22 of FIG. 21;

[0037] FIG. 23 is a vertical section showing another embodiment of a direct vent system of this invention positioned above a cooking appliance (in phantom); and

[0038] FIG. 24 is a circuit diagram of an integrated control system for an energy management system of this invention.

[0039] Corresponding reference number designate corresponding parts throughout the several views of the drawings.

DEFINITIONS

[0040] As used herein, the following terms have the meanings set forth below.

[0041] The term “atmospheric flue” means a flue without an air assist device.

[0042] The term “cooking appliance” means any apparatus which is used for cooking food and which emits hot gas and effluents during the cooking process. The appliance may have a single cooking chamber or multiple cooking chambers arrayed horizontally and/or vertically.

[0043] The term “hot gas” means heated air or other gas, including cooking gas and combustion gas.

[0044] The term “effluents” means particulate material entrained in the hot gas, including grease, moisture and other by-products of the cooking process.

[0045] The term “effluent-removal device” means one or more mechanisms for removing effluents from a gas, including catalysts, filters, precipitators, UV systems, or combinations thereof.

[0046] The term “exhaust area” means any area from which hot gas (either with or without effluents) exits the cooking appliance, including dedicated exhaust outlets, doors, other entrances and exits, apertures, or other openings in the cooking appliance.

[0047] The term “high-vent mode” means a time or portion of a cycle of operation of a cooking appliance when its
venting requirements are relatively high, as during a cook segment of a cycle when large amounts of hot gas and effluents requiring ventilation are generated.

[0048] The term "low-vent mode" means a time or portion of a cycle of operation of a cooking appliance when venting its requirements are relatively low, as during a warm-up or stand-by segment of a cycle, or when the appliance is off. The venting requirements (e.g., flow rate through the vent) during a low-vent mode are less than the venting requirements during a "high-vent" mode.

[0049] The term "open" means either fully open or partially open.

[0050] The term "closed" means a position more closed than the "open" position.

[0051] The term "variable-speed" as used in connection with a device (e.g., fan or motor) means that the device can operate at two or more speeds when it is in operation.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0052] Referring now to the drawings, FIGS. 1 and 2 illustrate a direct exhaust vent 1 of the present invention for venting a cooking appliance 3 (shown in phantom lines). The cooking appliance may be of various types, as noted above. Typically, hot gas and effluents will exhaust or escape from the cooking appliance at a number of different locations and in different ways. By way of example, traditional gas ovens will often have a combustion chamber exhaust, one or more doors providing access to the cooking chamber through which hot gas and effluents may escape when the door(s) is opened, and a cooking chamber exhaust separate from the combustion chamber exhaust. Electric ovens may not have a separate exhaust for combustion products. Other types of cooking appliances have cooking areas which are only partially enclosed, as in the case of fryers, charbroilers, rotisseries, brick ovens and broilers. For these types of appliances, hot gas and effluents are exhausted over a wide, unenclosed area as well as through discrete exhausts or apertures. In short, hot gas and effluents will exhaust or escape in different ways from different cooking appliances.

As a result, different appliances will have different ventilation requirements. As will be described hereinafter, the present invention is advantageous because it can be tailored to meet a broad range of such requirements, while at the same time providing for greater energy efficiency. Further, the required levels of effluent-removal, air supply and air exhaust can readily be designed into the direct exhaust vent or surrounding components of the overall ventilation system, as needed. The focused capture and specific treatment provided by the direct exhaust vent provides a more effective and adaptive ventilation system.

[0053] The cooking appliance 3 shown in FIGS. 1 and 2 may be a convective air oven, for example, having cooking and combustion chambers (not shown), a door 4 providing access to the cooking chamber, a first exhaust 5 at one location on the oven (e.g., for exhausting from the cooking chamber), and a second exhaust area 7 at a second location on the oven (e.g., for exhausting from the combustion chamber). Hot gas and effluents are exhausted from the exhaust area 5 to the direct exhaust vent 1 and from the exhaust area 7 via a flue 9 to the direct exhaust vent 1. As will be described in more detail below, the direct vent 1 may also capture hot gas and effluents from other exhaust areas.

[0054] The direct exhaust vent 1 can be mounted in different ways. In FIG. 1, for example, the vent 1 is secured to a surface (e.g., ceiling 21) of a building by support rods 23. Other mounting configurations are possible. For example, the direct exhaust vent can be mounted on a frame or stand separate from the building structure. The cooking appliance 3 is typically mounted on a support 13, which may be a stationary counter, a movable cart, or other structure for supporting the cooking appliance in a position below the direct exhaust vent 1.

[0055] If desired, the direct exhaust vent of this invention can be used in combination with a larger exhaust hood or canopy. FIGS. 3-5 illustrate such a combination in which a direct exhaust vent, generally designated 121, is mounted inside a larger exhaust canopy 123, and in which both the direct exhaust vent and canopy are mounted on a frame or stand 125. Alternatively, the direct exhaust vent and canopy can be secured directly to a surface of the building in which they are installed, as discussed previously. The lower inlet end of the exhaust canopy 123 is sized larger than the lower end of the direct exhaust vent 121 and normally larger than the footprint of the cooking appliance 3 for collecting any hot gas and effluents not collected by the direct exhaust vent. By way of example but not limitation, the open lower end of the exhaust canopy 123 may have an outline which extends up to six inches or more beyond opposite sides of the cooking appliance and up to twelve inches or more beyond the front of the cooking appliance. An exhaust fan (not shown) draws hot gas up through a main exhaust duct 131 of the exhaust canopy. One or more filters 135 are provided for filtering effluents (e.g., grease) from the hot gas. The volume of flow through the main exhaust duct 131 is preferably tailored to the size and flow requirements of the cooking appliance 3 and balanced with the flow required for the direct exhaust vent 121.

[0056] In the embodiment of FIGS. 3-5 the stand 125 has back and sides, a fire extinguishing system, power outlets, gas connection, fan motor starters and all wiring and interlocks for a complete system. There is a manual pull station on the stand 125; the gas valve is pre-piped; the electric shunt trip is pre-wired; and all interlocks are pre-wired. Nozzles are installed in the exhaust canopy 123, direct exhaust vent 121 and ductwork, as required. The stand 125 is preferably free standing and can be movable or secured in fixed position by fasteners (e.g., floor bolts) or the like. In any event, the stand preferably incorporates all features to allow the cooking appliance 3 to be positioned under the exhaust canopy 123, fitted or otherwise connected to the direct exhaust vent 121, and operated to begin cooking.

[0057] Optionally, the stand 125 may include an air supply duct 141 having an inlet 143 for connection to an outside source of air for providing additional make-up air to the cooking appliance 3 and surrounding environment (see FIGS. 3-5). This supply air may be conditioned, if desired. The air supply duct 141 has an outlet 145 at its lower end covered by removable perforated panels 147 or any other air direction device. A fan can be provided if make-up air is necessary. The air supply duct 141 and associated components can be used even if the stand 125 is not used.

[0058] FIG. 6 shows an embodiment of a direct exhaust vent 201 mounted inside an exhaust canopy 205. The canopy 205 has a filtered fan box 211 with an exhaust discharge 215 instead of a conventional exhaust duct and exhaust fan. The direct exhaust vent 201 of this embodiment is similar to the
direct exhaust vent 1 of the first embodiment except that the exhaust discharge 215 of the filtered fan box 211 is connected to an inlet 217 in the atmospheric flue 221 of the direct exhaust vent 201. As shown, the filtered fan box 211 has one or more baffles, screen mesh, and/or woven fiber-glass filters 225 (combined as necessary) and a fan 231. The filtered fan box and components are sized to generate a flow which is as low as possible but still sufficient to capture any hot gas and effluents which escape from the front or discharge end of the cooking appliance 3. Hot gas and effluents escaping through exhaust area 5 are exhausted up the direct exhaust vent 201 through the flue 221. If necessary or desirable, a small exhaust fan can be used to generate additional flow up through flue 221.

[0059] FIG. 7 illustrates a direct exhaust vent retrofit unit 301 which may be installed in the shell of an existing exhaust hood or canopy 303 having an exhaust duct 305. The unit 301 comprises an optional housing 307 sized to fit inside the existing canopy shell. In this embodiment, the housing 307 has top and side walls and contains the various direct exhaust vent components shown in FIG. 6, i.e., a direct exhaust vent 309, a fan box 311, filter 313, fan 315 and associated ductwork 317. The flue 319 of the direct exhaust vent 309 extends up the existing exhaust duct 305 of the exhaust canopy 303, although it will be understood that the flue 319 can be routed in other ways. If used, the housing 307 of the retrofit unit 301 is secured in position under the existing exhaust canopy 303 by suitable fasteners or other means. In other retrofit installations, one or more of the fan box 311, filter 313, and fan 315 may be eliminated.

[0060] FIGS. 8-11 illustrate a vent system 401 which combines a direct exhaust vent 403 of this invention and a NFPA TYPE I exhaust hood or canopy 405. In this embodiment the interior of the exhaust canopy 405 is divided by a partition 411 into a first section A and a second section B. The two sections A and B are connected by a main exhaust duct 415 and exhaust fan (not shown). Section A and the associated flow through this section are configured for collecting hot gas and effluents from a cooking appliance 419A positioned below the canopy 405 (FIG. 10). Grease filters 421 are provided as required. Make-up air may or may not be provided. The direct exhaust vent 403 is located in section B of the canopy (FIGS. 9 and 11). Section B may also include one or more grease filters 435. Most of the hot gas and effluents from the cooking appliance 419B are directed into the direct exhaust vent 403. The remaining hot gas and effluents are exhausted through the main exhaust duct 415. As a result, the air flow requirements are reduced substantially. The exhaust fan associated with the main exhaust duct 415 can be operated at different speeds, if desired, according to whether the cooking appliance is operating in a high-vent mode or a low-vent mode, resulting in further energy savings. In another embodiment a second direct exhaust vent may be added to Section B, and the atmosphere vents may be connected for one roof penetration. In yet another embodiment, hot gas and effluents can be directed from Section A, via suitable ducting, to the direct exhaust vent 403 in Section B for exhaust through the vent 403.

[0061] FIG. 12 shows an exemplary embodiment of a direct exhaust vent of this invention, generally designated 501. It comprises a first direct vent structure 533 defining a first flow path 535, an optional second direct vent structure 537 at least partially defining a second air flow path 539, and a flue 541 (atmospheric vent) communicating with the first and second air flow paths for exhausting hot gas to atmosphere. The first direct vent structure 533 has a lower inlet end 543 positioned adjacent (e.g., directly over) the exhaust area 5 of the cooking appliance, and an upper outlet end 545 in communication with the flue 541. The inlet end 543 of the first direct vent structure 533 is preferably adapted to be positioned adjacent the exhaust area 5 of the cooking appliance. In some embodiments, the lower inlet end 543 of the structure may be configured to fit over, around, in or in close proximity to the exhaust area 5 of the cooking appliance so that hot gas and effluents are directed from the cooking appliance upward along the first flow path 535. In other embodiments, the lower end 543 of the first direct vent structure may be detachably attached to the cooking appliance by a suitable attachment mechanism. Alternatively, the inlet end 543 of the first direct vent structure 533 may be positioned adjacent an exhaust area of the cooking appliance other than exhaust area 5. Further, while the first and second direct vent structures 533, 537 illustrated in FIGS. 12 and 13 are centered and symmetrical with respect to the central vertical axis of the flue 541, it will be understood that non-centered and asymmetric configurations are possible. For example, if the exhaust area 5 is at a non-central location on the top of the appliance 3, the first direct vent structure can be located directly over such non-central location. In this case, the first direct vent structure may have a central vertical axis laterally offset from a central axis of the second direct vent structure and/or from the central axis of the flue 541.

[0062] In the embodiment of FIG. 12, the first direct vent structure 533 comprises an upper part 533A which may optionally house other components of the system (described hereinafter) and a lower extensible part 533B which is capable of moving up and down relative to the upper part 533A. Specifically, the lower part 533B has a sliding telescoping fit with the upper part 533A so that it may be moved up and down as needed to the desired position with respect to the exhaust area 5 of the cooking appliance below. Alternatively, the lower part 533B could be extensible relative to the upper part 533A in other ways. The lower part 533B may have a sealing fit or connection with the cooking appliance 3, or it may have a loose (non-sealing) fit or connection with the cooking appliance, or it may simply be located adjacent the exhaust area 5 of the cooking appliance. In any case, the lower part 533B should be positioned and configured such that at least some, and preferably most if not substantially all of the hot gas and effluents exhausted from the area 5 of the cooking appliance are directed up along the first flow path 535 through the first direct vent structure 533.

In some embodiments, the dimension (e.g., diameter, length, width) of the lower end 543 of the first direct vent structure 533 is approximately the same as the dimension (e.g., diameter, length, width) of the exhaust area 5 of the cooking appliance. In other embodiments, the dimension of the lower end of the first direct exhaust vent is no more than one inch greater, or no more than two inches greater, or no more than three to six inches greater than the corresponding dimension of the exhaust area of the cooking appliance. The length of the first direct vent structure 533 and/or the extent of vertical adjustment provided by the lower part 533B can vary, depending on the type and style of cooking appliance to be vented and the elevation at which the direct exhaust vent system is mounted relative to the cooking appliance. By way
of example, the first direct vent structure can have a vertical adjustment (i.e., a range of extension) in the range of 0-18 in., or in the range of 1-12 in., or in the range of 2-8 in., or in the range of 4-6 in.

[0063] Although the first direct vent structure 533 is illustrated in FIG. 12 as being fabricated from two pieces of sheet metal, it will be understood that it could be fabricated from any number of parts and could have other configurations. For example, the structure 533 could be formed so the upper and lower parts 533A, 533B are formed as a single piece with no vertical adjustment feature. Also, the cross-sectional shape of the structure can vary from the rectangular shape shown in FIG. 12A. For example, it may be circular or have any polygonal shape.

[0064] In the embodiment of FIG. 12, the second direct vent structure 537 is configured as a small hood having a lower inlet end 549 and an upper outlet end 551 which communicates with the atmospheric flue 541 of the direct exhaust vent 501. The second (outer) direct vent structure 537 surrounds the first (inner) direct vent structure 533 and is spaced from that structure to define the second flow path 539 for exhaust of hot gas and effluents from the environment surrounding the cooking appliance 3. To capture these cooking by-products efficiently, the lower end 549 of the second direct vent structure 537 is preferably but not necessarily sized somewhat larger than the overall footprint of the cooking appliance 3, or at least the zone of the cooking appliance where this other hot gas and effluents are likely to escape. For example, the lower end of the second direct vent structure 537 may be sized to have a footprint which extends a distance of up to three inches beyond the footprint of the zone either all around the zone or parts of the zone. Alternatively, this distance may be up to six inches, or up to 12 inches or even more. In any event, hot gas and effluents escaping from the cooking appliance 3 at locations other than through the exhaust area 5 are directed along the second flow path 539 toward the flue 541 at the upper outlet end 551 of the second direct vent structure.

[0065] In the embodiment shown in FIG. 13, the second direct vent structure 537 is rectangular and extends all the way around the first direct vent structure 533 to define an annular flow path. However, it will be understood that the second direct vent structure 537 could have shapes other than rectangular (e.g., other polygonal shapes or circular). Further, the second direct vent structure 537 need not extend all the way or even part way around the first direct vent structure 533. For example, it may extend on only one, two or three sides of the first direct vent structure 533, so long as a second flow path defined by the second direct vent structure directs hot gas up through the flue 541, or through a separate flue, not shown. In one embodiment, the second direct vent structure could be a channel-shaped structure which overhangs the door 4 of the cooking appliance 3 for venting cooking by-products escaping through the door opening. In another embodiment, the second direct vent structure could be a duct with a closed cross-sectional shape having a lower inlet end at one side of the first direct vent structure and an upper outlet end which communicates with the flue 541.

[0066] A direct exhaust vent of this invention can include more than two direct vent structures if that is desired or necessary to meet the ventilation requirements of a particular cooking installation. For example, a third direct vent structure could be added to the direct exhaust vent 501 shown in FIG. 12. The third structure could be a separate flue, for example, similar to the flue 9 in FIGS. 1 and 2.

[0067] Depending on the type of food being cooked, the cooking appliance, and the ventilation requirements, the direct exhaust vent 501 may include an effluent-removal device. One type of such device is a catalyst. The use of one or more catalysts has advantages over a conventional grease filter system because a catalyst generally has lower flow requirements than a grease filter. That is, to operate effectively, most grease filters require high-velocity flow through the filter. In contrast, a catalyst is more efficient at lower flow velocities since the hot gas and effluents reside in the catalyst for a longer period of time for more effective treatment by the catalyst. As a result, the use of a catalyst system can result in substantial savings over a conventional grease filter system.

[0068] In the embodiment of FIG. 12, a first effluent-removal device 519A is positioned in the upper part 533A of the first direct vent structure 533 for treating hot gas flowing along the first flow path 535, and a second effluent-removal device 519B is positioned inside the second direct vent structure 537 above the first direct vent structure 533 for treating hot gas flowing along the first and second flow paths 535, 539. The removal of effluents entrained in the hot gas is necessary to keep the direct exhaust vent 501 free from grease build up and the need for grease filters. An interlock may be required to prevent operation of the cooking appliance without effluent-removal device(s) 519A, 519B in place. Each effluent-removal device 519A, 519B preferably is removable for cleaning. In some embodiments, the effluent-removal devices may be similarly sized so that they are interchangeable. In other embodiments, more or less than two effluent-removal devices can be used, as needed. For example, in some embodiments, only effluent-removal device 519A is used, and in other embodiments only effluent-removal device 519B is used. Further, different types of effluent-removal devices may be used in combination, depending on the cooking appliance and type of foods cooked.

[0069] The flow rate requirement of the direct exhaust vent 501, including the first and second (and any other) direct vent structures 533, 537, will vary depending on the particular installation and associated venting requirements. By way of example but not limitation, when the cooking appliance 3 is operating in a high-vent mode, the flow requirements of the direct exhaust vent 501 may be in the range of 0 to 220 CFM, or in the range of 30 to 200 CFM, or in the range of 50 to 180 CFM, or in the range of 60 to 150 CFM, or in the range of 70 to 120 CFM. These flow rates are substantially lower than the flow rates required by conventional ventilation systems, such as the large exhaust hoods or canopies of traditional design which often have flow requirements in the range of 150 to 450 CFM per linear foot of canopy. The result is improved energy efficiency and reduced operational costs. The direct exhaust vent 501 will also increase the capture of extraneous hot gas and effluents from the exhaust areas of the cooking appliance. Quick capture of the hot gas and effluents at the source reduces heat radiated into the environment surrounding the cooking appliance.

[0070] The direct exhaust vent 501 may or may not require a small air assist fan (either induced or exhaust) for generating additional flow through the vent, as needed or desired. The need for such a fan will depend on the particular
installation and flow requirements of the system. In general, however, the use of such a fan will tend to create more of a vacuum inside the cooking appliance to inhibit hot gas and effluents from exiting the cooking appliance except through intended exhaust outlets. The use of such a fan will also permit the use of a thicker or more flow-resistant effluent-removal device (e.g., catalyst). An air assist fan can be used and installed in different ways. One possible embodiment involves the use of an exhaust fan to pull air through a bypass duct branching off from the atmospheric flue 541 of the direct exhaust vent. In this embodiment, a damper is provided in the atmospheric flue at a location above the branch. When the fan is in operation, flow is induced up through the bypass duct to atmosphere. When the fan is no longer needed, the damper is opened for normal flow through the atmospheric vent to atmosphere. In any event, each cooking appliance will require a different direct exhaust vent configuration and control logic, depending on the food being cooked, the type of cooking appliance, its various modes of operation, and the vent requirements during such modes of operation. As an example, an atmospheric vent may be used in one mode of operation and powered exhaust may be used in a different mode of operation.

To use the direct exhaust vent 501, the exhaust area 5 of the cooking appliance 3 is positioned adjacent (e.g., directly below) the lower inlet end of the direct exhaust vent. To facilitate such placement, the second direct vent structure 537 may be provided with one or more openings extending up from the lower edge of the structure, to permit passage of any vertical structure (e.g., short exhaust flue) projecting above the top wall of the cooking appliance. Each opening has a closure (e.g., a hinged or sliding door) for closing the opening after the cooking appliance is moved to its proper position relative to the direct vent structure 501. The one or more openings also provide access to the first direct vent structure 533 when the cooking appliance is below the direct exhaust vent 501 in a position where access might otherwise be limited. After the cooking appliance has been moved into position, the lower part of the first direct vent structure is moved up or down or moved in some other manner (e.g., swung in a horizontal plane as permitted by a flexible member) as needed to place the structure in proper position relative to the exhaust area 5 of the cooking appliance. The ability to move the first direct vent structure relative to the cooking appliance facilitates removal of the cooking appliance 3 from the direct exhaust vent 501 for cleaning. However, it will be understood that the first direct vent structure could be non-movable. The flue 9 from the second exhaust area 7 of the cooking appliance 3 is also connected to the atmospheric flue 541. Alternatively, the flue 9 could be connected to the direct exhaust vent at other locations, such as to the second direct vent structure so that hot gas from the flue 9 enters the second flow path defined by the second direct vent structure.

FIG. 14 illustrates a direct exhaust vent 601 similar to the direct exhaust vent 501 of the previous embodiment except that a recirculation system 605 is incorporated as part of the atmospheric flue 607 of the direct exhaust vent. As shown, a portion of the hot gas flowing through the flue 607 is directed through this recirculation system 605, which includes a housing 615, a fan (not shown) in the housing and, preferably, one or more effluent-removal devices. Hot gas leaving the housing 615 is directed by means of a duct 617 back to the second direct vent structure 619 and recirculated through an effluent-removal device 621 located above the first direct vent structure 623. (The effluent-removal device 621 can be used or not used, as necessary for the particular application.) In one embodiment, the recirculation path in housing 615 has a spiral configuration for flow through multiple effluent-removal devices (not shown). While the duct 617 of this embodiment is shown as having an outlet connected to the second direct vent structure 619 at a location below the effluent-removal device 621, it will be understood that the outlet of the duct could be connected at other locations on the direct vent structure. Further, one or more separate flues from other exhaust areas of the cooking appliance may connect to the direct exhaust vent 601, as shown in FIGS. 1 and 2.

Referring again to FIG. 14, the direct exhaust vent 601 is provided with a damper system, generally designated 653. The system 653 comprises a damper member 655 mounted inside the upper part 623A of the first direct vent structure 623 below the effluent-removal device 621. The first direct vent structure 623 also includes a lower part 623B. The damper member 655 is mounted (e.g., pivoted) by a suitable mechanism to move between a closed position and an open position in which the plane of the damper member 655 is generally parallel to the direction of gas flow through the vent structure. In general, the damper member 655 is operable to open when the cooking appliance is operating in a high-vent mode and to close when the cooking appliance is operating in a low-vent mode. The damper member 655 is configured such that when it is open, it allows hot gas and effluents to flow to a first flow rate along the first flow path defined by the first direct vent structure 623. When the damper member 655 is closed, the rate of flow through the first direct vent structure is reduced to a second flow rate less than the first flow rate but preferably not cut off entirely, thus allowing hot gas and effluents to continue to vent during periods when the venting requirements of the cooking appliance are relatively low, but reducing heat loss from the cooking appliance for greater energy efficiency. By way of example but not limitation, the damper member 655 in its closed position may block at least about 66% of the cross sectional area of the first flow path (leaving about 34% or less of this area open), and even more preferably at least about 95% of the cross sectional area of the first flow path (leaving about 5% or less of this area open). Damper positions will vary based on fuel being used to heat the apparatus. While FIG. 14 does not illustrate an effluent-removal device mounted in the first direct vent structure 623 below the damper member 655, it will be understood that an effluent-removal device could be used at this location. In certain situations, the use of the damper member 655 can improve the efficiency of an effluent-removal device installed below the damper member, particularly a catalyst which operates more effectively at higher temperatures. In its closed position, the damper member will retain more heat in the cooking appliance, thus exposing the catalyst to higher temperatures for more efficient catalytic operation.

The damper member 655 can be configured in different ways. For example, in one embodiment, the damper member 655 is pivotally mounted on a shaft 657 and, when closed, has an outline which is only slightly smaller than the outline of the flow path through the first direct vent structure 623. The damper member 655 is perforated at 659 to permit some flow when it is in its closed position, the volume of
such flow depending on the size and number of perforations 659 in the damper member. Alternatively, the damper member may be formed as a solid (non-perforated) blade or baffle mounted on a shaft for rotation about an axis transversely offset from the longitudinal center of the damper member. In this latter embodiment, the damper member is configured such that when it is in its closed position, one edge of the damper member contacts or is immediately adjacent an inner surface of the first direct vent structure 623 and an opposite edge is spaced a larger distance from an inner surface of the first direct vent structure to allow a limited but still substantial volume of flow past the damper member. Other damper configurations are possible. For example, two or more damper members may be mounted side by side in the flow path for pivoting or horizontal sliding movement.

[0075] The damper member(s) 655 is preferably rotated or otherwise moved between its open and closed positions by at least one motor (not shown) connected to the shaft 657 by suitable linkage (also not shown). The damper motor is controlled to open and close the damper member(s) in an appropriate manner, preferably according to the operation of the cooking appliance 3 (e.g., whether it is operating in a low-vent mode or a high-vent mode). To provide a full range of flow control, the position of the damper member(s) may be adjustable to any number of positions between fully open and fully closed. A stepper motor or other suitable drive mechanism can be used for this purpose.

[0076] The use of the damper system 653 described above is optional, as noted previously. If a damper system is used, it is preferably mounted along the flow path to control flow through the first direct vent structure 623 communicating with the flue (atmospheric or non-atmospheric).

[0077] The damper system, if used, may be used in combination with an air assist device (e.g., induced or exhaust fan) to provide specific flow configurations through the vent system, depending on the type of cooking appliance used and/or the type of food being cooked and/or the level of effluents. For example, the air assist device can be used to provide additional flow through the second direct vent structure and/or associated ducts (e.g., flue 9 in FIG. 1). At the same time, the damper member(s) can be used to limit the amount of heat drawn from the cooking appliance through the exhaust area 5. The use of the air assist fan and damper system in this manner might arise in a situation where the environment surrounding the cooking appliance is particularly odorous as a result of the food being cooked, for example, or where additional vacuum is needed to pull combusion gas through the flue 9 of the direct exhaust vent 1. As noted above, the use of a damper system may also be beneficial if used in combination with certain types of effluent-removal devices, such as catalysts. In some embodiments, the damper can also be used to divert hot gas from the cooking appliance into a separate duct supplying make-up air or into a duct for re-circulation back to the cooking appliance (e.g., the cooking chamber).

[0078] FIG. 15 illustrates an embodiment similar to the one described above in FIG. 14 and corresponding parts are designated by the same reference numbers. The main difference is that the re-circulating duct 617 directs flow back to the cooking appliance 3 instead of back to the direct exhaust vent 601.

[0079] FIG. 16 illustrates an embodiment similar to FIG. 15 (corresponding parts being designated by the same reference numbers) except that the second direct vent structure is eliminated and the re-circulating duct 617 directs flow back to the first direct vent structure 623. Alternatively, the re-circulating duct 617 of FIG. 16 could direct flow back to the cooking appliance, as in FIG. 15.

[0080] FIG. 17 illustrates another embodiment of a direct exhaust vent of the present invention, generally designated 701. Direct exhaust vent 701 is similar in many respects to the direct exhaust vent 501 described above. Thus, direct exhaust vent 701 has a first direct vent structure 703 having an upper end 705 connected by means of a tapered connector 707 to an atmospheric flue 709. The direct vent structure defines a first flow path 711 which communicates with the flue 709 for redirecting hot gas up through the flue. In this embodiment, there is no second direct vent structure defining a second flow path to the flue. Optionally, this embodiment may also include one or more effluent-removal devices 713 and/or a damper system (not shown) comprising one or more damper members, as previously described. In another embodiment, a separate flue or flues may connect to the direct exhaust vent 709 as shown in FIGS. 1 and 2.

[0081] FIG. 18 shows another embodiment of a direct exhaust vent 801 of the present invention similar to the embodiment of FIG. 12 except that the lower effluent-removal device 803A is positioned in or on the cooking appliance 3 rather than in the first direct vent structure of the direct exhaust vent. By way of example, the device 803A can be mounted in a housing (not shown) attached to the cooking appliance at the exhaust area 5. Optionally, this embodiment may eliminate the second direct vent structure if the cooking appliance does not require it. Also, a damper system (not shown) of the type described above may be used in this embodiment, if desired or needed, either in combination with the effluent-removal device 803A or without an effluent-removal device. If a damper system is used, the damper member(s) can be mounted on the first direct vent structure, as previously described. Alternatively, the damper member(s) can be mounted on the cooking appliance, such as in the aforementioned housing for the effluent-removing device 803A, or other structure of the cooking appliance.

[0082] FIGS. 19-22 show another embodiment of a direct exhaust vent of the present invention, generally designated 1101. This embodiment is similar to the embodiment 501 of FIG. 12, and the description of the system 501 is incorporated into the description of system 901 to the extent it is not inconsistent. The system 1101 comprises a first direct vent structure 1133 positioned above an exhaust outlet or flue 5 of the cooking appliance 3, a second direct vent structure 1137 surrounding the first direct vent structure 1133, and an atmospheric flue 1141 attached to and extending up from the second direct vent structure 1137. The first and second direct vent structures define first and second air flow paths 1135, 1139, respectively. In this embodiment, the first (inner) direct vent structure 1133 is suspended in place by brackets 1159 which attach the first direct vent structure 1133 to the second direct vent structure 1137. Other means of attachment may be used.

[0083] In the illustrated embodiment 1101, the first direct vent structure 1133 comprises an upper part 1133A and a non-extensible lower part 1133B. However, it will be understood that the lower part could be extensible as described in regard to previous embodiments. The lower part 1133B is sized somewhat larger than the exhaust outlet 5 of the cooking appliance 3. The second (outer) direct vent structure 1137 is a double-wall structure comprising inner and outer
walls 1137A, 1137B which are spaced apart to receive insulating material 1161. A door 1163 is hinged to the front of the second direct vent structure 1137 adjacent the lower end of the structure. The door 1163 swings up to an open position to facilitate movement of the cooking appliance 3 to a position below the direct exhaust vent 1101 in which the exhaust outlet 5 of the appliance 3 is disposed directly below the first direct vent structure 1133. The door 1163 then swings down to a closed position. The door may move between its open and closed positions in other ways (e.g., by sliding).

[0084] The direct exhaust vent 1101 also includes two effluent-removal devices, namely, a lower device (e.g., a catalyst) 1167 positioned in the exhaust outlet 5 of the cooking appliance 3 where it is supported by one or more brackets 1169 or other supporting device, and an upper device (e.g., a catalyst) 1171 positioned above the upper (outlet) end of the first direct vent structure 1133 where it is supported by one or more brackets 1181 or other suitable supporting device affixed to the second direct vent structure 1137. An opening 1183 is provided in the second direct vent structure 1137 to facilitate installation and removal of the upper effluent-removal device 1171. When the upper device 1171 is in place, a plate 1187 affixed to the device closes the opening. Suitable fasteners are used to secure the plate 1187 and catalyst 1171 in place.

[0085] The direct exhaust vent of FIGS. 19-22 also includes a damper assembly generally designated 1191. The assembly comprises a damper housing 1195 at the lower end of the first direct vent structure 1133 and one or more (two are shown) damper members 1201 mounted in the housing for movement between open and closed positions. The damper members 1201 are supported on the housing by shafts 1205, and the shafts are rotated by a suitable mechanism 1209 which may comprise suitable linkage and/or gearing connected to a drive motor or motors (not shown) mounted on or adjacent the direct vent structure 1133 or on the appliance 3. In the illustrated embodiment, the damper assembly 1191 is not attached to the first direct vent structure 1133. The damper housing 1195 extends down into the exhaust outlet 5 of the appliance 3 to a position in which the lower end of the housing is adjacent the lower effluent-removal device 1169. By way of example, the lower end of the housing may be supported by the same bracket or brackets 1169 supporting the lower effluent-removal device 1167. Gas exhausted from the cooking appliance 3 flows up through the lower effluent-removal device 1169, the damper housing 1195, the first direct vent structure 1133, and the upper effluent-removal device 1171 to the atmospheric flue 1141 of the direct vent system. The damper assembly 1191 is removable from the outlet of the appliance 3 to permit replacement of the lower effluent-removal device 1169.

[0086] In the embodiment of FIGS. 21 and 22, the damper assembly 1191 includes a collar 1215 surrounding the damper housing 1195 for capturing additional cooking gas from the cooking appliance 3 and directing it up to the inner direct vent structure 1133. The collar 1215 is preferably attached to the housing 1195 (as by welding) and is disposed on or immediately above the top surface of the cooking appliance 3. The collar 1215 is of suitable shape. By way of example, in the illustrated embodiment, the collar 1215 is generally rectangular and has a front wall spaced forward from the front of the damper housing 1195 to direct cooking gas escaping from the cooking appliance 3 in this area up to the lower end of the first direct vent structure 1133. The collar 1215 is configured such that when the cooking appliance 3 is in place below the direct exhaust vent 1101, the lower end of the first direct vent structure 1133 is positioned either on or immediately above the upper end of the collar 1215. The upper end of the collar 1215 has a peripheral flange 1225 which functions to reinforce the collar and also to provide a surface which may be contacted by the lower part of the first direct vent structure 1133, as where the lower part is extensible.

[0087] As shown in FIGS. 21 and 22, the catalyst 1167 is disposed in the lower end of the damper housing 1195 below the damper members 1201. The use of the damper members can improve the efficiency of the catalyst, particularly a catalytic which operates more effectively at higher temperatures. In the closed position, the damper member(s) 1201 will retain more heat in the cooking appliance 3, thus exposing the catalyst 1167 to higher temperatures for more efficient catalytic operation. There are advantages to this design. First, when closed, the damper members 1201 conserve energy by reducing the air flow through the appliance. Second, when closed, the damper members reduce the escape of heat and maintain the catalyst at a higher temperature (e.g., about 775 degrees Fahrenheit) at which the catalyst is essentially self-cleaning, thus eliminating the need for sophisticated controls to sense the condition of the catalyst. Further, because the temperature of the catalyst is maintained at a higher level, it remains ready to incinerate effluents, thereby eliminating any delay for warm-up before cooking. A third advantage is that the normal cooking process heat generated by the appliance is sufficient to keep the catalyst clean so that additional ancillary devices to generate heat needed to clean the catalyst are not necessary. This is in contrast to prior art devices as shown, for example, in PCT International Application No. PCT/US97/10550 (Publication No. WO 97/48479), requiring a separate burner pack or the like to heat the catalyst to clean it.

[0088] Although not specifically shown in the drawings, it will be understood that the catalyst 1167 could be located in the exhaust area of the cooking appliance 3 immediately upstream from (below) the damper housing 1195 rather than actually in the damper housing itself, so long as the damper, when closed, functions to reduce the escape of heat from the appliance and thus maintain the catalyst at an elevated temperature.

[0089] FIG. 23 shows another embodiment of a direct exhaust vent 901 of the present invention similar to the embodiment of FIG. 12 except that one or more effluent-removal devices 903 are placed in the atmospheric flue 905 of the vent. A heater 913 (e.g., an induction coil or some other type of heater) is used to heat the effluent-removal device(s) to increase the efficiency of the effluent-removal device(s). Alternatively, the effluent-removal device 903 and heater 913 could be located in the first direct vent structure 915 or in the second direct vent structure 917, if a second direct vent structure is used. If a re-circulation system is used, a heater and effluent-removal device can be used in the re-circulation system. A damper system (not shown) of the type previously described can be used in this embodiment, if necessary or desired. In the embodiment of FIG. 23, an effluent-removal device 921 is provided in the first direct vent structure 915.

[0090] If desired, the electronic controls for the cooking appliance and ventilation system can be integrated to pro-
vide an integrated control and energy management system to achieve more efficient ventilation and improved energy management. In such an integrated control system, the control panel on the cooking appliance 3 or a separate control panel may provide all control functions for the relevant components of the ventilation system, including any supply and exhaust fans associated with the direct exhaust vent, any supply and exhaust fans associated with the exhaust canopy, if the latter is used, and any damper system. Thus, for example, when the cooking appliance is operating in a high-vent mode, one or more of any such fans are operated at a higher speed and the damper system, if used, is moved to an open position. When the cooking appliance is operating in a low-vent mode, one or more of any such fans are operated at a lower speed (including off), and the damper system, if used, is moved to a closed position. Thus, the controls for the cooking appliance may be used to provide for maximum efficiency and reduced air flow and heat loss.

[0091] FIG. 24 shows an exemplary integrated control system, generally designated 1001, for controlling the operation of a direct exhaust vent system of the present invention, described above, in coordination with the operation of a cooking appliance 3. This system includes the combination of a control panel 1007 for inputting information into the system, and a microprocessor 1013 having inputs and outputs for receiving and sending information with respect to various components of the appliance and vent system. These components include, for example, one or more exhaust fans 1021; one or more air make-up fans 1023; one or more bypass dampers 1025; one or more induced draft fans 1027; one or more heaters 1029 for heating respective one or more exhaust-removal devices; one or more filtered fan boxes 1035; one or more appliance dampers 1037; one or more damper position sensors 1041; one or more exhaust-removal device position sensors 1043 for sensing whether a respective exhaust-removal device is in position; one or more photoelectric sensors 1047 for sensing the absence or presence of effluents in the hot gas from the appliance, in response to which fan speed can be suitably controlled; one or more temperature sensors 1051 for sensing the temperature at respective one or more locations in the direct exhaust vent (e.g., above an effluent-removal device which may tend to overheat under certain circumstances); one or more sensors for sensing the activation of a safety system such as a fire extinguisher system 1053 (e.g., a UL-approved R102 system) associated with the vent system; one or more appliance position sensors 1057 for sensing whether the cooking appliance 3 is in proper position relative to the vent system; and one or more shunt trip breakers 1061 for cutting off power to the cooking appliance under certain conditions, e.g., in the event sensor 1053 senses the activation of a safety system, or in the event the appliance position sensor 1057 senses that the cooking appliance is not in proper position relative to the vent. The exhaust fan(s) 1021 and air make-up fan(s) 1023 are driven by suitable drives 1071 (e.g., a single-speed drive for driving a fan at only one speed, not including "off", and/or a variable-speed drive for driving the fan at two or more speeds, not including "off"); the bypass damper(s) 1025, induced draft fan(s) 1027, heater(s) 1029, filtered fan box(es) 1035, appliance damper(s) 1037, photovoltaic sensor(s) 1047, temperature sensor(s) 1051 and shunt trip breaker(s) 1061 are associated with relays 1081; and the damper position sensor(s) 1041, effluent-removal device position sensor(s) 1043, extinguisher system(s) 1057 and appliance position sensor(s) 1061 are associated with micro-switches 1091. The drives 1071, relays 1081 and micro-switches 1091 suitably communicate with microprocessor, as will be understood by the skilled person. Other control systems may be used, the system in FIG. 24 being only a schematic illustration of one possible system. The particular cooking appliance and combination of vent components under the control of the control system will vary from installation to installation. In general, however, it will be understood that there is a communication link between the appliance control and the vent system control so that components of the vent system (e.g., one or more dampers and/or fans) are controlled in response to the operation of the cooking appliance, as when the cooking appliance is moving through various segments of its operational cycle, such as the cycle described below.

[0092] An exemplary operational cycle for a cooking appliance is described below. In this embodiment, the cooking appliance is a broiler having upper and lower burners for cooking food in a cooking cavity or chamber. A direct exhaust vent as described above (e.g., as shown in FIGS. 19-22) is provided for exhausting hot gas and effluents from the cooking appliance. Each operational cycle of the broiler in this example includes the following segments: start-up, idle, cook, and standby. These segments are described below.

[0093] During the start-up segment, all burners (lower and upper) are turned on and the broiler cooking cavity is heated to a predetermined temperature T1 (e.g., 680 degrees F.). The damper of the vent system 1101 is in its closed position to conserve energy (i.e., to reduce heat loss.) If an exhaust fan is used, the fan is turned off. After the temperature in the cavity reaches T1, as sensed by a suitable temperature sensor, the idle segment starts.

[0094] During the idle cycle segment, the upper burners are on and the lower burner cycles to maintain the broiler cavity temperature at temperature T1. The appliance remains in the idle cycle until the appliance is used in a cook cycle or is turned off.

[0095] The cook segment is initiated by an operator actuating a suitable control, such as one of a series of pushbuttons, each of which may correspond to a particular cooking recipe for a particular food. During the cook cycle, all burners are initially on, the upper burners cycle based on time in the cook cycle, and the lower burner cycles off when the cavity temperature, as sensed by a suitable sensor, reaches a maximum cooking temperature T2 higher than T1 (e.g., 775 degrees F.). The damper is opened at or about the start of the cook cycle so that hot gas and effluents (e.g., smoke) produced by the cooking are vented. If an exhaust fan is used, the fan is turned on. The cook segment continues according to the programmed cooking recipe at a suitable temperature or temperatures for suitable time period or periods. At the end of the cooking recipe the damper closes to conserve energy and the appliance enters the idle cycle. If desired, an operator can initiate a second or next cook cycle following the end of the preceding cook cycle. However, to conserve energy, if a predetermined time interval (e.g., two minutes) elapses without initiation of another cook cycle, the standby segment of the operational cycle is initiated.

[0096] During the standby cycle segment, the upper burners are turned off and the lower burner cycles to maintain the broiler cavity at a predetermined temperature (e.g., T1). The
damper is also moved to its closed position to conserve energy. If an exhaust fan is used, the fan is turned off. If food product is to be cooked, an appropriate control (e.g., push-button) is actuated to terminate the standby cycle and initiate the idle segment described above to prepare the broiler for cooking. At the end of the idle segment, a cook segment is started by actuating a suitable control, such as a pushbutton, corresponding to the particular food to be cooked, as described above.

To conserve additional energy, it may be desirable in some situations (e.g., where little or no smoke is generated during the initial phase of the cook cycle segment) to divide the cook segment of the cycle described above into two sub-segments, i.e., a first cook/pre-smoke sub-segment and a second cook/smoke sub-segment. During the first sub-segment, all burners are on, and the lower burner cycles off when cavity temperature reaches an appropriate maximum cooking temperature (e.g., T2). Food product in the broiler is cooking but is not producing smoke. During this sub-segment, the damper remains in a closed position to conserve energy. The cook/pre-smoke sub-segment continues for a predetermined (programmed) period of time, which may vary depending on the type of food being cooked, following which the cook/smoke sub-segment is initiated. During this sub-segment, the damper is opened to exhaust hot gas and effluents from the cooking appliance. If an exhaust fan is used, the fan is turned on. As during the previous cook/pre-cook sub-segment, all burners are on, and the lower burner cycles off when the cavity temperature reaches the desired maximum cooking temperature (e.g., T2).

The number and type of cycle segments and/or sub-segments in an operational cycle will vary from one cooking appliance to another. Further, successive operational cycles may vary from one cycle to the next. By way of example, a first cycle may include start-up, idle, cook, cook, and standby segments, and a second cycle may include start-up, idle and cook segments. The present invention contemplates all such variations. In general, the method contemplates the basic steps of operating the cooking appliance in a cycle having different cycle segments, and varying the flow characteristics of the vent system as a function of the cycle segment. The integrated control system controlling the vent system and the cooking appliance operates to vary the flow characteristics of the vent system (e.g., by opening or closing dampers and/or changing fan speed) to accommodate the venting requirements of the different cycle segments.

In general, a vent system of this invention may be broadly described as a system for venting a cooking appliance (e.g., 3) having a first exhaust area (e.g., 5) for exhausting hot gas and effluents from the cooking appliance. The cooking appliance may also have a second exhaust area (e.g., exhaust outlet 7, door 4, relief vents, or other apertures) other than the first exhaust area through which hot gas and effluents escape. The vent system generally includes a first direct vent structure (e.g., 533) defining a first flow path (e.g., 535) for venting substantially only hot gas and effluents from the first exhaust area (e.g., 5), and an optional second direct vent structure (e.g., 537) defining a second flow path (e.g., 539) for venting substantially only hot gas and effluents from the second exhaust area (e.g., 7). In one embodiment (e.g., the FIG. 12 embodiment described above), the second (outer) direct vent structure surrounds the first (inner) direct vent structure and combines with the first direct vent structure to define the second flow path. The first and second air flow paths preferably communicate with a common atmospheric flue (e.g., 541) for exhausting hot gas to atmosphere. In other embodiments, the first and second air flow paths can communicate with separate flues. In still other embodiments, the second direct vent structure (e.g., 537) can be eliminated entirely, as shown in FIG. 17. And in yet other embodiments, a third direct vent structure (e.g., flue 9 in FIGS. 1 and 2) can be added to define a third flow path to vent hot gas from a different location (e.g., the combustion chamber of an oven) through the same atmospheric flue (e.g., 541) used by the first and/or second direct vent structures, or through a different flue dedicated to the third flow path.

A ventilation and energy management system of this invention may have one or more of the features described above, or any combination of such features. These features include a fully integrated control system for controlling the operation of the cooking appliance and ventilation system so that the ventilation requirements of the cooking appliance are met efficiently and in a way which conserves energy. The ventilation system of this invention can also be used with conventional hood canopies, either in an original installation or in a retrofit installation, to increase ventilation efficiency and to conserve energy. If necessary or desirable to meet the particular ventilation requirements of a cooking system, more than one direct exhaust vent of this invention can be used in parallel. In such a situation, the vents can exhaust through separate atmospheric flues, or through a common atmospheric flue. The ventilation system may also include an optional damper system for controlling the flow from the cooking appliance to achieve energy savings. The damper system can be used in combination with a direct exhaust vent described herein, or it can be used separately on the cooking appliance.

A vent system having one or more of the features described above will provide one or more advantages, including but not limited to: flexibility and adaptability for integration with various types of cooking appliances; the capture and disposition of hot gas and effluents in an energy efficient manner; adaptability to meet different effluent-removal requirements; integration of the vent system with the particulars of the cooking process, foods cooked and cooking appliance; less maintenance and cleaning of the vent system components; and a substantial step toward meeting the standards of an energy efficient or “green” restaurant, a goal which is becoming more and more important.

When introducing elements of the present invention or the preferred embodiments thereof, the articles “a”, “an”, “the” and “said” are intended to mean that there are one or more of the elements. The terms “comprising”, “including” and “having” are intended to be inclusive and mean that there may be additional elements other than the listed elements.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions, products, and methods without departing from the scope of the invention, it is intended that all matter
contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A vent system for venting hot gas and effluents from a cooking appliance, said vent system comprising
   a direct exhaust vent adapted to be positioned above the cooking appliance,
   said direct exhaust vent comprising a first direct vent structure having an inlet for receiving said hot gas and effluents and an outlet communicating with atmosphere,
   said first direct vent structure defining a first flow path from said inlet to said outlet for flow of said hot gas and effluents along the flow path,
   at least one effluent-removal device in said first flow path for removing effluents from said hot gas, and
   an atmospheric flue communicating with the outlet of the first direct vent structure for venting hot gas to atmosphere after it has passed through said effluent-removal device.

2. A system as set forth in claim 1 wherein said direct vent structure is movable so that it may be positioned adjacent an exhaust area of said cooking appliance.

3. A system as set forth in claim 2 wherein said direct vent structure has an upper section and a lower section movable up and down relative to the upper section to facilitate positioning adjacent said exhaust area of the cooking appliance.

4. A system as set forth in claim 1 wherein said direct exhaust vent further comprises a second direct vent structure having an inlet for receiving hot gas and effluents and an outlet communicating with said atmospheric flue, said second direct vent structure at least partially defining a second flow path for directing hot gas and effluents from the environment surrounding said cooking appliance to said outlet of the second direct vent structure.

5. A system as set forth in claim 4 further comprising a second effluent-removal device in said second flow path.

6. A system as set forth in claim 5 wherein said second direct vent structure surrounds said first direct vent structure and is spaced from the first direct vent structure to define said second flow path.

7. A system as set forth in claim 1 further comprising an exhaust canopy having an exhaust duct and a powered exhaust fan for collecting hot gas and effluents from an environment surrounding said cooking appliance, said direct exhaust vent being mounted inside said exhaust canopy.

8. A system as set forth in claim 1 further incorporating a damper system comprising a damper member movable in the first direct vent structure between an open position allowing flow along the first flow path at a first flow rate and a closed position allowing flow along the first flow path at a second flow rate less than the first flow rate but greater than zero to allow venting of the cooking appliance while also reducing heat loss from the cooking appliance.

9. A vent system for cooking appliance having a first exhaust area for exhausting cooking hot gas and effluents from the cooking appliance and a second exhaust area through which cooking hot gas and effluents escape the cooking appliance, said vent system comprising
   a first direct vent structure defining a first flow path for receiving hot gas and effluents from said first exhaust area,
21. An integrated cooking and ventilation system comprising
a cooking appliance,
a vent system for venting hot gas and effluents from said
cooking appliance, said vent system comprising at least
one movable venting component and at least one motor
for moving the at least one venting component, and
an integrated control system for controlling operation of
said at least one motor and associated venting compo-
nent as a function of the operation of the cooking
appliance.

22. A system as set forth in claim 21 wherein said at least
one movable venting component is a variable-speed fan
driven by said at least one motor, said control system being
operable to operate said fan at a first lower speed during a
low-vent mode of the cooking appliance and at a second
higher speed during a high-vent mode of the cooking
appliance.

23. A system as set forth in claim 21 wherein said at least
one movable venting component is a damper member mov-
able by said at least one motor between open and closed
positions, said control system being operable to move said
damper member to its closed position when the cooking
apparatus is operating in a low-vent mode and to its open
position when the cooking apparatus is operating in a
high-vent mode.

24. A system as set forth in claim 23 wherein said damper
member in its said open position allows flow along a first
flow path at a first flow rate through the vent system, and
wherein said damper member in its said closed position only
partially blocks the first flow path for flow at a second flow
rate less than said first flow rate but greater than zero to
allow venting of the cooking appliance while also reducing
heat loss from the cooking appliance.

25. A system as set forth in claim 24 further comprising
a catalyst in said first flow path upstream from said damper
member whereby movement of the damper member to its
closed position is adapted to reduce heat loss from the
cooking appliance and catalyst.

26. An integrated cooking and ventilation system com-
prising
a cooking appliance,
a vent system for venting hot gas and effluents from said
cooking appliance, and
an integrated control system for controlling operation of
said vent system and said cooking appliance,
said integrated control system being responsive to opera-
tion of the cooking appliance to vary flow characteristics
of the vent system.

27. An integrated cooking and ventilation system as set
forth in claim 26 wherein said vent system comprises a
damper member movable between an open position to allow
the flow of hot gas and effluents from the cooking appliance
along a flow path at a first flow rate and a closed position
partially blocking the flow path for flow of hot gas and
effluents from the cooking appliance at a second flow rate
less than said first flow rate but greater than zero to allow
venting of the cooking appliance while also reducing heat
loss from the cooking appliance, said control system being
operable to move said damper member to its closed position
when the cooking apparatus is operating in a low-vent mode
and to its open position when the cooking apparatus is
operating in a high-vent mode.

28. An integrated cooking and ventilation system as set
forth in claim 27 further comprising a catalyst in said flow
path upstream from said damper member whereby move-
ment of the damper member to its closed position is adapted
to reduce heat loss from the cooking appliance and catalyst.

29. A method of operating a cooking appliance and vent
system for venting hot gas and effluents from the cooking
appliance, said method comprising
operating the cooking appliance, and
varying the flow characteristics of the vent system as a
function of the operation of the cooking appliance.

30. A method as set forth in claim 29 further comprising
operating the cooking appliance in a cycle having different
cycle segments, and varying the flow through the vent
system as a function of the cycle segments.

31. A method as set forth in claim 30 wherein said vent
system comprising at least one movable venting component
and at least one motor for moving the at least one venting
component, said method further comprising controlling said
at least one motor to move said at least one venting
component to increase or decrease the flow through the vent
system as a function of the cycle segment.

32. A method as set forth in claim 30 wherein said venting
component is a damper.

33. A method as set forth in claim 30 wherein said venting
component is a fan.

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