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(54) **CORONA-DISCHARGE AIR MOVER AND PURIFIER FOR FIREPLACE AND HEARTH**

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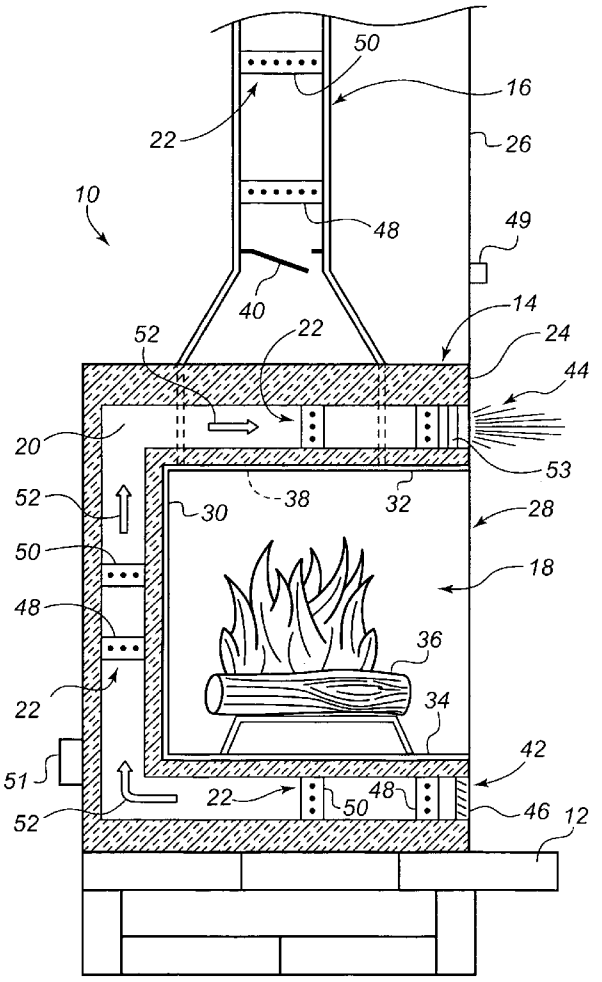
(57) **ABSTRACT**

A fireplace for warming an environment is provided. The fireplace comprise a combustion chamber, a passage, and at least one corona discharge apparatus. The passage is adjacent to the combustion chamber and extends between an inlet and an outlet. The at least one corona discharge apparatus is position within the passage to draw a fluid into the passage through the inlet and to expel the fluid through the outlet.



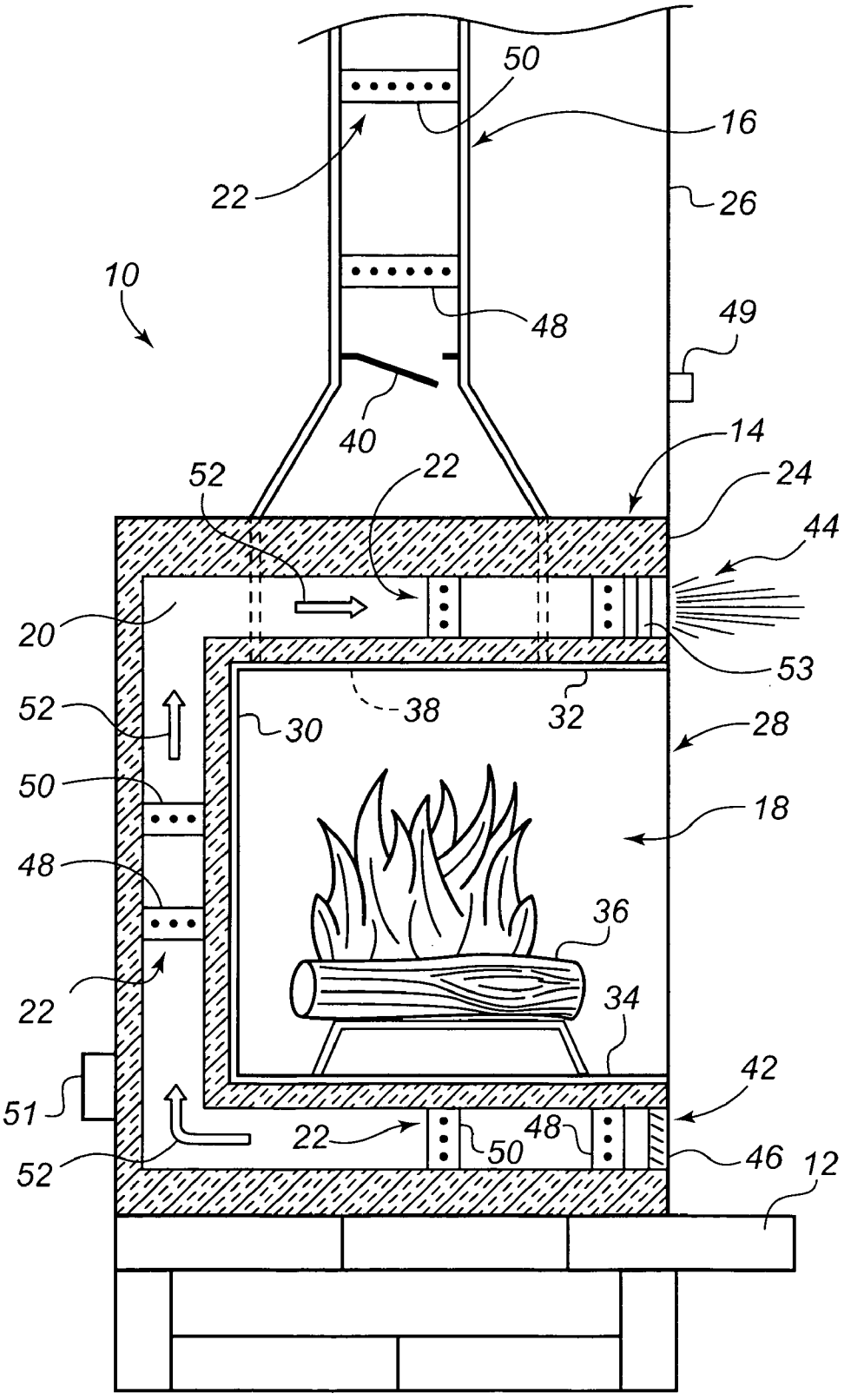

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FIG. 1

CORONA-DISCHARGE AIR MOVER AND PURIFIER FOR FIREPLACE AND HEARTH

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

[0001] This patent application claims the benefit of U.S. Provisional Patent Application No. 60/632,226, filed Nov. 30, 2004, the teachings and disclosure of which are hereby incorporated in their entireties by reference thereto.

FIELD OF THE INVENTION

[0002] This invention pertains to fireplace and hearth heating systems, and more particularly to blowers for use in fireplace and hearth heating systems.

BACKGROUND OF THE INVENTION

[0003] Fireplaces typically employ conventional rotating air movers such as fans and blowers to draw return air into a duct or plenum, force it through a heat exchanger, and then expel heated air back out into the room. An air filter may be added to further condition the air.

[0004] Unfortunately, fans and blowers tend to be noisy, especially in the relative quiet of a living room or bedroom. Furthermore, fans and blowers contain rotating and moving parts that usually wear out over time. Conventional air filters need to be replaced periodically, which increases the cost of ownership of such a system.

[0005] Therefore, an apparatus that can quietly move, and perhaps even filter, the air that is heated by a fireplace without rotating parts would be desirable. The invention provides such an apparatus. These and other advantages of the invention, as well as additional inventive features, will be apparent from the description of the invention provided herein.

BRIEF SUMMARY OF THE INVENTION

[0006] In view of the above, the present invention provides a new and improved air mover and purifier for a fireplace and hearth that overcomes one or more problems existing in the art. More particularly, the present invention provides a new and improved air mover and purifier for residential fireplace and hearth heating systems having a forced air duct or plenum.

[0007] In one embodiment of the present invention, the invention replaces a fan or blower with a corona-discharge air-moving apparatus that contains no moving parts. The invention is quieter, more efficient and more reliable than fans or blowers and provides air purification without the use of external filters or devices.

[0008] In one aspect, the invention provides a fireplace. The fireplace comprises a combustion chamber, a passage, and at least one corona discharge apparatus. The passage is adjacent to the combustion chamber and extends between an inlet and an outlet. The at least one corona discharge apparatus is positioned within the passage to draw a fluid into the passage through the inlet and to expel the fluid through the outlet.

[0009] In another aspect, the invention provides a corona-discharge air mover and purifier apparatus for a fireplace having a combustion chamber configured to receive a fuel. The fuel generates heat within the combustion chamber when combusted. A passage adjacent to the combustion chamber extends between an inlet and an outlet. The corona-discharge air mover and purifier apparatus comprises a first positively charged emitter array adapted to be positioned in the passage and a first negatively charged collector array adapted to be positioned in the passage in spaced relation to the first positively charged emitter array. The first positively charged emitter array and the first negative charged collector array are operative to cooperatively produce an electric wind in the passage. As such, air is drawn from the environment into the passage through the inlet, heated from the combustion chamber, and expelled through the outlet into the environment to warm the environment during combustion of the fuel in the combustion chamber.

[0010] In yet another aspect, the invention provides method of heating an environment using a fireplace having a combustion chamber configured to receive a fuel. The fuel generates heat within the combustion chamber when combusted. A passage is adjacent to the combustion chamber and extends between an inlet and an outlet. The method comprises the step of installing a corona discharge apparatus in the passage. The installed corona discharge apparatus is then energized to produce an electric wind in the passage. The electric wind results in air being drawn from the environment into the passage through the inlet, heated from the combustion chamber, and expelled through the outlet into the environment to warm the environment during combustion of the fuel in the combustion chamber.

[0011] Other aspects, objectives and advantages of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The accompanying drawings incorporated in and forming a part of the specification illustrate several aspects of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

[0013] **FIG. 1** is a simplified side view of an exemplary embodiment of a fireplace including an air moving apparatus constructed in accordance with the teachings of the present invention.

[0014] While the invention will be described in connection with certain preferred embodiments, there is no intent to limit it to those embodiments. On the contrary, the intent is to cover all alternatives, modifications and equivalents as included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Referring to **FIG. 1**, a hearth or fireplace **10** constructed in accordance with the teachings of the present invention, which may be installed, e.g., in a residential dwelling or commercial building, is illustrated. As will be described more fully below, the fireplace **10** of the present invention is constructed to quietly move a fluid (e.g., air) through the fireplace without the need for moving or rotating parts.

[0016] As shown, the fireplace **10** may sit on a base **12** and comprises a body **14** and a flue **16**. The base **12** is preferably constructed of a heat and fire resistant material such as stone, brick, concrete, and the like. Such a base **12** for the fireplace **10** typically rests on and above the foundation of the structure and generally supports the body **14**. The flue **16**, which sits atop the body **14**, is configured to transport hot gases to the chimney (not shown) and out of the structure.

[0017] The body **14** includes a combustion chamber **18**, a passage **20**, and one or more corona discharge apparatuses **22**. The body **14** of the fireplace **10** defines a front face **24** that conventionally faces toward an environment such as a living room, bedroom, and the like. Since the fireplace **10** can be installed in a flush or recessed orientation, the front face **24** of the body **14** can be planar or offset from a wall **26**.

[0018] The combustion chamber **18** has an open front **28** that is generally exposed to the environment. This open front **28** may be closed off by glass doors or the like in highly efficient embodiments. In such embodiments, the combustion chamber **18** is often fed with outside air to support the combustion. In addition, the combustion chamber **18** defines a back wall **30**, a floor **32**, and a roof **34**. The combustion chamber **18** is sized, dimensioned, and otherwise configured to receive a fuel **36** such as, for example, wood, natural gas, pellets, and the like. When the fuel **36** is combusted, heat is generated within the combustion chamber **18**.

[0019] The roof **34** of the combustion chamber **18** includes an aperture **38** that couples the combustion chamber **18** and the flue **16**. Therefore, when a damper **40** in the flue **16** is opened, the smoke and other combustion byproducts produced by the combusted fuel **36** is able to rise and pass upwardly through the flue **16**. To promote the ascension of the smoke and other combustion byproducts, one or more of the roof **34** and flue **16** can include a portion that is upwardly canted or contoured.

[0020] The passage **20** in the body **14** extends between an inlet **42** and an outlet **44**. The inlet **42** and outlet **44** each open through the front face **24** of the body **14** as shown in **FIG. 1**. In the illustrated embodiment, the outlet **44** is disposed vertically above the inlet **42**. This allows the passage **20** to take in cooler air near the floor of the dwelling to increase the occupants' comfort. Each of the inlet and outlet **42**, **44** can be protected by a cover **46**, a grate, and the like. As **FIG. 1** depicts, in one embodiment all or at least a portion of the passage **20** is proximate and/or adjacent to the combustion chamber **18** to increase the ability of the heat in the combustion chamber **18** to heat the air in the passage **20**. Preferably, the passage **20** runs along a substantial portion of the combustion chamber **18**.

[0021] In the illustrated embodiment of **FIG. 1**, the passage **20** begins at the inlet **42**, passes beneath the floor **34**, skirts the back wall **30**, runs along the roof **32**, and then terminates at the outlet **44**. As such, the heat generated by the combusted fuel **36** in the combustion chamber **18** can be conductively and/or convectively transferred to the air moving through or residing in the passage **20**.

[0022] Each of the corona discharge apparatuses **22** in the passage **20** is an electrical device that relies on corona discharge and ion charge attraction to move air and, preferably, filter particles and pollutants from the air. In the illustrated embodiment, three of the corona discharge apparatuses **22** are shown in the passage **20** although more or fewer may be used.

[0023] A typical corona discharge apparatus **22** employs numerous corona discharge electrodes **48** arranged in arrays and spaced apart from numerous negatively charged attracting electrodes **50** that are also arranged in arrays. When assembled into an array, the corona discharge electrodes **48** can be referred to as an emitter array. Likewise, the attracting electrodes **50** can be referred to a collector array. Due to the many array configurations and electrode shapes that can be used, the arrays of the corona discharge electrodes **48** and the attracting electrodes **50** have been shown in **FIG. 1** in a simplified form.

[0024] Each of the corona discharge electrodes **48** and attracting electrodes **50** is coupled to and charged by a high-voltage power supply **51**. The electrodes **48** and **50** are also preferably controlled and/or managed by related control electronics (not shown). In addition, the corona discharge electrodes **48** are typically asymmetrical with respect to the attracting electrodes **50**. In one embodiment, the corona discharge electrodes **48** are highly curved and resemble the tip of a needle or a narrow wire while the attracting electrodes **50** take the form of a flat plate or a ground plane. The curvature of the corona discharge electrodes **48** ensures a high potential gradient around that electrode.

[0025] The high potential gradient generated at or near the corona discharge electrodes **48** basically pulls apart the neutral air molecules in the immediate area. What remains after each neutral air molecule has been dismantled is a positively charged ion and a negatively charged electron. Due to the strong electric field near the corona discharge electrode **48**, the ion and electron are increasingly separated from each other, prevented from recombining, and accelerated. Therefore, the ion and electron are both imparted with kinetic energy. Moreover, since a portion of the air molecules in the passage **20** is ionized, the air in the passage becomes a conducting medium, the circuit including the corona discharge electrodes **48** and the attracting electrodes **50** is completed, and a current flow can be sustained.

[0026] The negatively charged electrons are persuaded to move toward the positively charged corona discharge electrodes **48** due to the difference in charge between them. When the rapidly moving and accelerating electrons collide with other neutral air molecules in the area, further positive ion/electron pairs are created. As more and more positive/ion electric pairs are produced, an electron avalanche is established. The electron avalanche sustains and/or perpetuates the corona discharge process.

[0027] In contrast to the negatively charged electrons, the positively charged ions are persuaded to move from near the corona discharge electrodes **48** toward the attracting electrodes **50**. This movement is due to the difference in charge between the positively charged ions and the negatively charged attracting electrodes. Like the electrons, when the positively charged ions move they also collide with neutral air molecules. When they collide, the positively charged ions can transfer some of their momentum as well as excess charge to the neutral air molecules. Therefore, the neutral air molecules are knocked toward the attracting electrode **50** or are ionized and then drawn to the attracting electrode **50**. In either case, the positively charged ions and other air mol-

ecules end up flowing from the corona discharge electrodes **48** toward the attracting electrodes **50**.

[**0028**] The movement or flow of the air particles away from the corona discharge electrodes **48** and toward the attracting electrodes **50** causes or results in what is referred to by those skilled in the art as an electric wind or electrostatic fluid acceleration. In the illustrated embodiment of **FIG. 1**, the electric wind travels through the passage **20** in a direction depicted by arrows **52**.

[**0029**] In one embodiment, the velocity and volume of the air moving through the passage **20** is proportional to the voltage difference between the electrodes **48**, **50** and the size of the arrays. By varying the potential between the electrodes **48**, **50**, the size and dimensions of the passage, and the like, the velocity and volume of the electric wind can be increased and decreased over a continuous range as desired. In any particular configuration, this range may be manually adjusted with a simple adjustment knob **49** or remote control that varies the electric potential between the electrodes **48**, **50**. With the appropriate configuration, air flows exceeding six hundred cubic feet per minute are possible.

[**0030**] When the positively charged ions creating the electric wind reach the attracting electrodes **50**, the positive charge is removed by permitting a recombination of the negatively charged electrons with the positively charged ions. Due to the recombination, neutral air molecules once again exists in the passage **20**. Advantageously, these neutral air molecules retain their velocity and direction.

[**0031**] In a preferred embodiment, one or more corona discharge apparatuses **22** can be disposed within either or both of the passage **20** and the flue **16** for the purpose of cleaning and scrubbing the air. Such beneficial and desirable filtering can be performed in addition to generating the electric wind. As known to those skilled in the art, contaminants and particles tend to adhere to the attracting electrode **50** during the corona discharge process. Therefore, both the air passing through the passage **20** and the exhaust gases exiting the combustion chamber **18** and being expelled from the structure can be purified. Notably, the attracting electrodes **50**, which are often plates, are preferably removable to permit inspection, cleaning, and replacement. In an alternative embodiment, the entire corona discharge apparatuses **22** are removable. Moreover, besides providing air movement and air cleaning, the corona discharge apparatuses **22** may also control flue airflow in an oscillatory manner to achieve unique combustion effects.

[**0032**] As is known in the art, several patents and published applications have recognized that corona discharge devices may be used to generate ions and accelerate and filter fluids such as air. Such patents and published applications that describe fluid and/or air moving devices and technology include the following U.S. Pat. Nos. 3,638,058, 3,699,387, 3,751,715, 4,210,847, 4,231,766, 4,380,720, 4,643,745, 4,789,801, 5,077,500, 5,667,564, 6,176,977, 6,504,308, 6,664,741, and 6,727,657 and U.S. Pub. Pat. Applns. 2004/40217720, 2004/0212329, 2004/0183454, 2004/0155612, 2004/0004797, 2004/0004440, 2003/0234618, and 2003/0090209. The teachings and disclosure of each of these patents and published applications are incorporated in their entireties by reference thereto.

[**0033**] While other ion discharge or corona fluid movement technologies may be employed in the system and method of the present invention, a preferred embodiment of the present invention utilizes the technology described in one or more of the preceding patents and/or published applications, and most preferably, the technology described in U.S. Pat. Nos. 6,504,308, 6,664,741, and 6,727,657 issued to Kronos Advanced Technologies, Inc., of Belmont, Mass. The teachings and disclosure of each of these patents are also incorporated in their entireties by reference thereto.

[**0034**] In a preferred embodiment, the fireplace **10** further comprises an ozone depletion apparatus **53** for reducing the amount of ozone in the fluid. In general, the ozone depletion apparatus **53** is any system, device, or method having the ability to degenerate ozone into oxygen (i.e., dioxide) and/or absorb ozone. In particular, the ozone depletion apparatus **53** can be a filter, a catalyst composition situated proximate the fluid, and the like. When the fireplace **10** is equipped with the ozone depletion apparatus **53**, the ozone generated by the corona discharge apparatuses **22** can be maintained below a desired level, relegated to within a predetermined range, and otherwise managed.

[**0035**] While the ozone depletion apparatus **53** can be situated in a variety of different locations relative to the one or more corona discharge apparatuses **22**, the ozone depletion apparatus is preferably disposed within the passage **20** proximate the outlet **44**. In an exemplary embodiment, the ozone depletion apparatus **53** is generally downstream of the last corona discharge apparatus **22** in the fireplace **10**. As such, air flowing out of the outlet **44** is purified by the ozone depletion apparatus **53** prior to entering the environment.

[**0036**] As is known in the art, several patents have recognized that ozone depletion devices and systems may be used to convert ozone to oxygen, absorb ozone, and the like. Such patents that describe converting and absorbing devices, methods, and technology include the following U.S. Pat. Nos. 4,343,776, 4,405,507, 5,422,331, 6,375,902, 6,375,905, and 6,699,529. The teachings and disclosure of each of these patents are incorporated in their entireties by reference thereto.

[**0037**] In operation, air is drawn into the passage **20** of the fireplace **10** through the inlet **42** due to the activation of one or more of the corona discharge apparatuses **22** and the corona discharge process as discussed above. Once drawn inside the passage **20**, the air (or particles thereof) continues to move through the passage **20** in the direction indicated by the arrows **52**. While residing within the passage **20**, the heat from the fuel **36** being combusted in the combustion chamber **18** is conductively and/or convectively transferred to the air.

[**0038**] After the air flowing through the passage **20** has been heated, the air is expelled and/or exhausted into the environment through the outlet **44** by the corona discharge process. Since the air has been heated by the combustion of the fuel **36** in the combustion chamber **18**, an ambient temperature of the environment is elevated. In other words, the environment is warmed by the air that has circulated through the fireplace **10** and been heated.

[**0039**] In a preferred embodiment, at least one of the corona discharge apparatuses **22** illustrated in **FIG. 1** also filters and cleans the air traveling through the passage **20** of the fireplace **10**. In a further preferred embodiment, at least one of the corona discharge apparatuses **22** filters and scrubs the exhaust gases leaving the combustion chamber **18**.

[0040] Advantageously, the present invention provides quieter hearth or fireplace **10** operation compared to when a mechanical fan or a blower is employed. The present invention also allows for a smaller, more flexible footprint than a large, circular shaped fan or blower will allow. This enables a larger combustion chamber **18** in the same overall volume for the hearth or fireplace **10**. Moreover, the air can be purified by the corona discharge apparatuses **22** and the velocity of the air can be variably controlled.

[0041] All references, including publications, patent applications, and patents cited herein are hereby incorporated by reference to the same extent as if each reference were individually and specifically indicated to be incorporated by reference and were set forth in its entirety herein.

[0042] The use of the terms "a" and "an" and "the" and similar referents in the context of describing the invention (especially in the context of the following claims) is to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The terms "comprising,""having,""including," and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to,") unless otherwise noted. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention.

[0043] Preferred embodiments of this invention are described herein, including the best mode known to the inventors for carrying out the invention. Variations of those preferred embodiments may become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventors expect skilled artisans to employ such variations as appropriate, and the inventors intend for the invention to be practiced otherwise than as specifically described herein. Accordingly, this invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the invention unless otherwise indicated herein or otherwise clearly contradicted by context.

What is claimed is:

1. A fireplace comprising:

a combustion chamber;

a passage adjacent to the combustion chamber, the passage extending between an inlet and an outlet; and

at least one corona discharge apparatus positioned within the passage to draw a fluid into the passage through the inlet and to expel the fluid through the outlet.

2. The fireplace of claim 1, wherein the inlet is positioned below the combustion chamber so as to allow cooler fluid to be drawn into the passage, and wherein the outlet is positioned above the combustion chamber to allow to fluid in the passage to be heated when fuel is combusted in the combustion chamber.

3. The fireplace of claim 1, further comprising means operatively coupled to the at least one corona discharge apparatus for varying a flow rate of the fluid through the passage.

4. The fireplace of claim 1, wherein the inlet and the outlet are formed in a front face of the fireplace and the outlet is disposed vertically above the inlet.

5. The fireplace of claim 1, wherein the fireplace further comprises an ozone depletion apparatus for removing ozone from the fluid.

6. The fireplace of claim 1, wherein the passage is oriented relative to the combustion chamber to heat the fluid within the passage.

7. The fireplace of claim 1, further comprising a flue coupled to a roof of the combustion chamber, the flue including at least one corona discharge apparatus positioned therein for filtering smoke and other combustion byproducts during combustion within the combustion chamber.

8. The fireplace of claim 7, wherein at least one electrode in the at least one corona discharge apparatus is removable from the flue for inspection, cleaning, and replacement.

9. The fireplace of claim 7, wherein the at least one corona discharge apparatus positioned within the flue permits a variable flow of air to flow through the flue to control the combustion in the combustion chamber.

10. The fireplace of claim 1, wherein the at least one corona discharge apparatus comprises a positively charged emitter array in spaced relation to a negatively charged collector array.

11. The fireplace of claim 1, wherein the at least one corona discharge apparatus moves the fluid through the passage at about six hundred cubic feet per minute when energized.

12. The fireplace of claim 1, wherein at least one of the at least one corona discharge apparatuses is removably positioned in the passage to allow cleaning thereof.

13. The fireplace of claim 1, wherein the fireplace further includes a high voltage power supply operatively coupled to the at least one corona discharge apparatus.

14. A corona-discharge air mover and purifier apparatus for a fireplace having a combustion chamber configured to receive a fuel, the fuel generating heat within the combustion chamber when combusted, and a passage adjacent to the combustion chamber, the passage extending between an inlet and an outlet, comprising:

a first positively charged emitter array adapted to be positioned in the passage; and

a first negatively charged collector array adapted to be positioned in the passage in spaced relation to the first positively charged emitter array, the first positively charged emitter array and the first negative charged collector array being operative to cooperatively produce an electric wind in the passage such that air is drawn from the environment into the passage through the inlet, heated from the combustion chamber, and expelled through the outlet into the environment to warm the environment during combustion of the fuel in the combustion chamber.

15. The apparatus of claim 14, further comprising a second positively charged emitter array adapted to be positioned in the passage and a second negatively charged collector array adapted to be positioned in the passage in spaced relation to one another such that they cooperatively aid the electric wind in the passage.

16. The apparatus of claim 14, wherein the first positively charged emitter array and the first negative charged collector array operative to cooperatively filter the air drawn from the environment and flowing in the passage.

17. The apparatus of claim 14, further comprising a second positively charged emitter array adapted to be positioned in a flue of the fireplace and a second negatively charged collector array adapted to be positioned in the flue in spaced relation to the second positively charged emitter array, the second positively charged emitter array and the second negative charged collector array being operative to cooperatively produce an electric wind in the flue to aid combustion in the combustion chamber.

18. A method of heating an environment using a fireplace having a combustion chamber configured to receive a fuel, the fuel generating heat within the combustion chamber when combusted, and a passage adjacent to the combustion chamber, the passage extending between an inlet and an outlet, the method comprising the steps of:

installing a corona discharge apparatus in the passage;

energizing the corona discharge apparatus to produce an electric wind in the passage such that air is drawn from the environment into the passage through the inlet, heated from the combustion chamber, and expelled through the outlet into the environment to warm the environment during combustion of the fuel in the combustion chamber.

19. The method of claim 18, wherein the step of installing the corona discharge apparatus comprises the steps of:

installing a first positively charged emitter array in the passage;

installing a first negatively charged collector array in the passage in spaced relation to the first positively charged emitter array.

20. The method of claim 19, wherein the step of installing the corona discharge apparatus further comprises the steps of:

installing a second positively charged emitter array in the passage;

installing a second negatively charged collector array in the passage in spaced relation to the second positively charged emitter array.

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