A device for drawing dilution air into a flue pipe extending from a furnace toward a chimney is disclosed. The device comprises first and second members. The first member includes an inlet and an outlet. The inlet is connectable to a furnace side of the flue pipe to receive flue gas therefrom. The outlet of the first member discharges the flue gas out of the first member. The second member include a body, a base, an outlet, a mixing chamber, and at least one louver. The base extends from the body toward the first member and has an opening fitted around the first member so that the outlet of the first member is positioned within the body of the second member and a flow passage is formed between the first member and the body of the second member. The outlet of the second member is connectable to a chimney side of the flue pipe. The mixing chamber receives the flue gas discharged from the outlet of the first member and the dilution air from the louver(s). The dilution air at least partially mixes with the flue gas in the mixing chamber before it is discharged with the flue gas to the chimney side of the flue pipe through the outlet of the second member.
DEVICE FOR DRAWING DILUTION AIR

RELATED APPLICATIONS

[0001] This application claims the benefit of the U.S. provisional application no. 60/260,881, filed Jan. 12, 2001, which is expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] This invention generally relates to devices for drawing dilution air. More particularly, the present invention relates to a device for drawing dilution air into a flue pipe of a furnace to eliminate the need to reline a masonry chimney with a metal liner.

[0003] Category I furnaces operate with a non-positive vent static pressure and have a flue gas temperature of more than 140°F above the dew point temperature. The Annual Fuel Utilization Efficiency (AFUE) of Category I furnaces ranges from 75% to 83%. In order to obtain the minimum required AFUE, a fan is typically added to a furnace. The fan added to a furnace, however, also lowers the flue gas temperature. As a result, the flue gas may condense and corrode a masonry chimney, a chimney typically used for venting of the flue gas.

[0004] Accordingly, the current National Fuel Gas Code, ANSI Z223.1/NFPA 54, does not permit venting of a fan-assisted Category I furnace into an unlined masonry chimney, unless there is a source of dry dilution air. To meet this code requirement, a masonry chimney is typically relined with a metal liner. Relining a masonry chimney with a metal liner, however, is costly and time consuming. Accordingly, there is a need for a device that eliminates the need to reline a masonry chimney with a metal liner.

SUMMARY OF THE INVENTION

[0005] Accordingly, the present invention is directed to a device for drawing dilution air into a flue pipe of a furnace that eliminates the need to reline a masonry chimney with a metal liner. The advantages and purposes of the invention will be set forth in the description which follows, and in part will be obvious from the description, or will be realized and attained by the elements and combinations particularly pointed out in the appended claims.

[0006] To attain the advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, the invention is directed to a device for drawing dilution air into a flue pipe extending from a furnace toward a chimney. The device comprises first and second members. The first member includes an inlet and an outlet. The inlet is connectable to a furnace side of the flue pipe to receive flue gas therefrom. The outlet of the first member discharges the flue gas out of the first member. The second member include a body, a base, an outlet, a mixing chamber, and at least one louver. The base extends from the body toward the first member and has an opening fitted around the first member so that the outlet of the first member is positioned within the body of the second member and a flow passage is formed between the first member and the body of the second member. The outlet of the second member is connectable to a chimney side of the flue pipe. The mixing chamber is formed between the outlet of the first member and the outlet of the second member to receive the flue gas discharged from the outlet of the first member. The at least one louver extends through the body to draw the dilution air into the second member so that the dilution air flows through the flow passage and at least partially mixes with the flue gas in the mixing chamber before being discharged to the chimney side of the flue pipe through the outlet of the second member with the flue gas.

[0007] In another aspect, the invention is directed to a device for drawing dilution air into a flue pipe extending from a furnace toward a chimney. The device comprises first and second members. The first member includes an inlet and an outlet. The inlet is connectable to a furnace side of the flue pipe to receive flue gas therefrom. The outlet of the first member discharges the flue gas out of the first member. The second member include a body, an outlet, a mixing chamber, and a plurality of louvers. The body is disposed around the first member and contains the outlet of the first member therein. The outlet of the second member is connectable to a chimney side of the flue pipe. The mixing chamber is formed between the outlet of the first member and the outlet of the second member to receive the flue gas discharged from the outlet of the first member. The mixing chamber is an open space laterally defined by the body. The louvers extend through the body and positioned below the mixing chamber to draw the dilution air into the second member so that the dilution air at least partially mixes with the flue gas in the mixing chamber before being discharged to the chimney side of the flue pipe through the outlet of the second member with the flue gas.

[0008] In another aspect, the invention is directed to a device for drawing dilution air into a flue pipe extending from a furnace toward a chimney. The device comprises first and second members. The first member includes an inlet, an outlet, and a tapered portion. The inlet is connectable to a furnace side of the flue pipe to receive flue gas therefrom. The outlet of the first member discharges the flue gas out of the first member. The tapered portion is positioned between the inlet and outlet and tapers inwardly toward the outlet. The second member include a body, an outlet, a mixing chamber, and at least one louver. The body is disposed around the first member and contains the outlet of the first member therein. The outlet of the second member is connectable to a chimney side of the flue pipe. The mixing chamber is formed between the outlet of the first member and the outlet of the second member to receive the flue gas discharged from the outlet of the first member. The mixing chamber has a cross sectional area greater than the outlet of the second member. The at least one louver extends through the body at a portion below the outlet of the first member to draw the dilution air into the second member so that the dilution air at least partially mixes with the flue gas in the mixing chamber before being discharged to the chimney side of the flue pipe through the outlet of the second member with the flue gas.

[0009] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate...
an embodiment of the invention and together with the description, serve to explain the principles of the invention. In the drawings,

[0011] FIG. 1 is a side view of a device according to the present invention;

[0012] FIG. 2 is a sectional view of the device taken along line B-B of FIG. 1;

[0013] FIG. 3 is a bottom view of the device shown in FIG. 1; and

[0014] FIG. 4 is a perspective view of a furnace and the device shown in FIG. 1 installed vertically on top of the furnace.

DETAILED DESCRIPTION

[0015] Reference will now be made in detail to the presently preferred embodiment of the present invention, an example of which is illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0016] In the embodiment illustrated in FIGS. 1-4, a device for drawing dilution air into a flue pipe is designated generally by reference number 10. Device 10 is adapted to be installed to a flue pipe (not shown) extending from a furnace 30 (FIG. 4) toward a chimney (not shown). Preferably, furnace 30 is a gas furnace producing flue gas to be discharged to a chimney. Device 10, however, may also be used with any furnace producing flue gas to be discharged to a chimney.

[0017] As illustrated in FIGS. 1-3, device 10 includes a first member 11 and a second member 12. Preferably, first member 11 is a pipe having a circular cross section. First member 11, however, may have different cross sectional shapes. First member 11 includes an inlet 16 and an outlet 18. Inlet 16 is connectable to a furnace side of the flue pipe to receive the flue gas produced by furnace 30 and discharged into the furnace side of the flue pipe. In the embodiment illustrated in FIGS. 1 and 4, inlet 16 is sized to fit outside the furnace side of the flue pipe and is connectable to the furnace side of the flue pipe by one of more screws 19. Instead of one of more screws 19, other known means or methods may be used to connect inlet 16 of first member 11 to the furnace side of the flue pipe. Outlet 18 discharges the flue gas out of first member 11.

[0018] As illustrated in FIG. 2, first member 11 includes a first portion 34, which is cylindrical in shape, a second portion 36, which is frustoconical in shape, and a third portion 38, which is cylindrical in shape. This design tends to funnel the flue gas and provide an optimum fluid flow for the application of the invention.

[0019] In the embodiment illustrated in FIGS. 1-4, second member 12 includes a body 14 and a base 17. Preferably, body 14 is a pipe having a square (or rectangular) cross section. Body 14 of second member 12, however, may have different cross sectional shapes. As shown in FIGS. 2 and 3, the cross sectional area of body 14 is preferably greater than any cross sectional area of first member 11.

[0020] Base 17 is connected to body 14 and extends from body 14 toward first member 11 as shown in FIGS. 1-3. Base 17 has an opening 20 fitted around first member 11 so that outlet 18 of first member 11 is positioned within body 14 of second member 12 and a flow passage 25 is formed between body 14 of second member 12 and first member 11. Base 17 is connected to first member 11, preferably in a sealed relationship. For example, base 17 can be connected to first member 11 by a plurality of tabs 15 extending between base 17 and first member 11. The plurality of tabs 15 are preferably connected to first member 11 and base 17 of second member 12 by spot welding. The present invention, however, encompasses other means, such as screws, bolts or the like, to connect tabs 15 and base 17 of second member 12. Although preferred, an air-tight seal is not required between first member 11 and opening 20 of base 17.

[0021] In the embodiment illustrated in FIGS. 1-4, second member 12 further includes an outlet 22, a mixing chamber 24, and at least one louver. As shown in FIG. 1, second member 12 preferably has a plurality of louvers 26. Outlet 22 is formed in a panel 23 connected to body 14 of second member 12 and is connectable to a chimney side of the flue pipe. Panel 23 is preferably attached to body 14 in a sealed relationship. Although preferred, a sealed relationship is not required between panel 23 and body 14 of second member 12. Preferably, outlet 22 is sized to be fit inside the chimney side of the flue pipe so that panel 23 prevents the chimney side of the flue pipe from being inserted into body 14 of second member 12. Because inlet 16 of first member 11 and outlet 22 of second member 12 are connectable respectively to the furnace and chimney sides of the flue pipe, device 10, when installed, replaces a portion of the flue pipe between furnace 30 and a chimney.

[0022] As illustrated in FIG. 2, mixing chamber 24 is formed between outlet 18 of first member 11 and outlet 22 of second member 12. As described above, the chimney side of the flue pipe fits outside of outlet 22 of second member 12 and does not extend into mixing chamber 24. Accordingly, mixing chamber 24 is an open space laterally defined by body 14 and axially defined by panel 23. Mixing chamber 24 receives the flue gas discharged from outlet 18 of first member 11.

[0023] As illustrated in FIGS. 1 and 4, second member 12 further includes a plurality of louvers 26 extending through body 14 thereof. Dilution air is drawn into second member 12 through louvers 26 and flows through flow passage 25 into mixing chamber 24. Louvers 26 preferably are all formed below mixing chamber 24. As shown in FIG. 2, louvers 26 in the illustrated embodiment are formed at or below the frustoconical portion 36 of first member 11 and in the bottom half of body 14 of second member 12. In mixing chamber 24, the dilution air at least partially mixes with the flue gas discharged from outlet 18 of first member 11. The flue gas and the dilution air, at least partially mixed in mixing chamber 24, are then discharged into the chimney side of the flue pipe.

[0024] As described above, body 14 of second member 12 is preferably a square (or rectangular) pipe having four side surfaces 28. For body 14 having four side surfaces 28, no louvers 26 are provided on at least one of the four side surfaces 28.

[0025] Preferably, only one of the four side surfaces 28 has no louvers 26 while the remaining three side surfaces 28 have louvers 26. As will be explained below, the side surface
This portion of side surface without louvers 26 faces upwardly when device 10 is installed horizontally or at an angle. For a second member of different cross sectional shape (e.g., a second member having a circular cross section), a portion of its side surface includes no louvers 26.

The flue gas from furnace 30 (FIG. 4) enters inlet 16 of first member 11 from the furnace side of the flue pipe. The flue gas then flows through first member 11.

Outlet 18 discharges the flue gas out of first member 11 and into mixing chamber 24. At the same time, the pressure differential caused by the flow of the flue gas draws dilution air into mixing chamber 24 through louvers 26. Although the temperature differential along the flue pipe contributes to the creation of the pressure differential, the flow of the flue gas alone is sufficient to create the pressure differential necessary to draw the dilution air into mixing chamber 24. Accordingly, as soon as furnace 30 is turned on, device 10 starts to draw dilution air into mixing chamber 24 without having to wait for the temperature differential along the flue pipe to develop.

The flue gas and the dilution air, at least partially mixed in mixing chamber 24, exit second member 12 through outlet 22 and flow into the chimney side of the flue pipe. Further mixing occurs as the flue gas and the dilution air flow in the chimney side of the flue pipe. The mixture of the flue gas and the dilution air then enters a chimney, which eventually discharges the mixture outside. When furnace 30 is turned off after a sufficiently long operation, a pressure differential, created by the aforementioned temperature differential along the flue pipe, draws air through louvers 26 and discharges it into the chimney for a period of time. This air dries up any condensate that might have formed in the chimney while furnace 30 was in operation.

Device 10 is preferably installed vertically on top of furnace 30 as shown in FIG. 4. However, device 10 may be installed anywhere along the flue pipe between furnace 30 and a chimney. Also, device 10 may be installed horizontally or at an angle.

When device 10 is installed horizontally or at an angle, the side surface of body 14 without louvers 26 faces upwardly so that the flue gas does not flow out of device 10 through louvers 26. When installed vertically, outer pipe 12 may be positioned in any orientation.

Device 10 installed on any fan-assisted Category I furnace eliminates the need to line a masonry chimney with a metal liner. Although the dilution air reduces the flue gas temperature, it also reduces the dew point temperature of the flue gas. Thus, by controlling the amount of the dilution air drawn into second member 12, device 10 maintains the reduced flue gas temperature above the reduced dew point temperature and prevents the flue gas from condensing inside a masonry chimney. The number and size of louvers 26 control the amount of dilution air drawn into second member.

Depending on the capacity of furnace 30, the number and size of louvers 26 may change accordingly to provide the necessary amount of dilution air to maintain the reduced flue gas temperature above the reduced dew point temperature. In addition, the dilution air, flowing through the masonry chimney for a period of time after the gas furnace is turned off, dries up any condensate that might have formed inside the masonry chimney while the furnace was in operation.

As shown in FIGS. 2 and 3, the cross sectional area of mixing chamber 24 is greater than outlet 22 of second member 12. Thus, the flue gas entering the chimney side of the flue pipe from second member 12 flows through a reduced area.

This reduction in flow area develops a pressure differential across outlet 22 (i.e., a venturi effect) and helps to discharge the flue gas into the chimney side of the flue pipe without spilling it out of second member 12 through louvers 26. In addition, base 17, having opening 20 fitted around first member 11, helps to retain the flue gas within second member 12.

Device 10 can be used for any Category I furnaces (i.e., AFUE from 75% to 83%) using Natural, Propane, Butane, or Propane-Air gases. As described above, device 10 can be installed anywhere along the flue pipe between a furnace and a chimney either vertically, horizontally, or at an angle. When installed horizontally or at an angle, the side of second member 12 without louvers 26 faces upwardly so that the flue gas does not flow out of device 10 through louvers 26. When installed vertically, second member 12 may be positioned in any orientation. Device 10 can be installed on any type of flue pipe, including single wall vent pipe and type-B double wall vent pipe. Furthermore, device 10 can be used with upflow, counterflow (downflow), and horizontal furnaces. Preferably, device 10 is to be used with upflow and counterflow (downflow) furnaces.

The following dimensions are provided to further illustrate one exemplary embodiment of the present invention. It should be recognized that the following dimensions are exemplary in nature and do not limit the scope of the present invention.

In one exemplary embodiment of the present invention, first member 11 is a pipe having a circular cross section and a length of about 5.56". Inlet 16 of first member 11 has a diameter of about 4" while outlet 18 of first member 11 has a diameter of about 3.5. Body 14 of second member 12 is a pipe having a square cross section.

Body 14 of second member 12 has a length of about 6" and a width of about 5". Outlet 22 has a diameter of about 4".

Each of three side surfaces of body 14 of second member 12 includes six louvers 26. Each louver 26 is about 2.07" long and about 0.44" wide. Each louver 26 is rounded at its corners with a circle having a diameter of about 0.44". The first pair of louvers 26 (FIG. 1) from base 17 is positioned about 0.75A from base 17. The second and third pairs are positioned respectively about 1.5A and 2.25A from base 17. The distance between outlet 18 of first member 11 and outlet 22 of second member 12 (d in FIG. 2) is about 1.44A.

Again, these dimensions are provided for the sole purpose of further illustrating one exemplary embodiment of
the present invention. They are not intended and should not be interpreted to limit the scope of the present invention.

[0042] The operation of the aforementioned device will now be described with reference to the attached drawings.

[0043] A blower 32 (or a fan) of furnace 30 (FIG. 4) blows the flue gas through the furnace side of the flue pipe and into inlet 16 of first member 11. The flue gas then flows through first member 11 and into mixing chamber 24 through outlet 18. The flue gas then flows into the chimney side of the flue pipe connected to outlet 22. The flue gas flowing through first and second members 11 and 12 creates a pressure differential to draw dilution air into mixing chamber 24 through louver 26 and flow passage 25. As the flue pipe heats up, a temperature differential developed along the flue pipe also helps to create the pressure differential to draw dilution air into mixing chamber 24.

[0044] Although the temperature differential along the flue pipe helps, the flow of flue gas alone is sufficient to create the pressure differential necessary to draw dilution air into mixing chamber 24. Accordingly, as soon as furnace 30 is turned on, device 10 starts to draw dilution air into mixing chamber 24 without having to wait for the temperature differential along the flue pipe to develop.

[0045] The flue gas and the dilution air at least partially mix in mixing chamber 24 before exiting second member 12 into the chimney side of the flue pipe connected to outlet 22. Further mixing occurs as the flue gas and the dilution air flow in the chimney side of the flue pipe. The mixture of the flue gas and the dilution air then enters a chimney, which eventually discharges the mixture outside. The dilution air reduces the dew point temperature of the flue gas and therefore prevents the flue gas from condensing inside the chimney. Consequently, even if a masonry chimney is used, no metal liner is needed because no condensation is formed inside the chimney.

[0046] When furnace 30 is turned off after a sufficiently long operation, a pressure differential, created by the temperature differential developed along the flue pipe, draws air through louver 26 and discharges it into the chimney for a period of time. This drafting action, dries up any condensate that might have formed in the chimney while furnace 30 was in operation.

[0047] It will be apparent to those skilled in the art that various modifications and variations can be made in the device of the present invention without departing from the scope or spirit of the invention. Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein.

What is claimed is:

1. A device for drawing dilution air into a flue pipe extending from a furnace toward a chimney, comprising:
   a first member including:
      an inlet connectable to a furnace side of the flue pipe to receive flue gas therefrom; and
      an outlet to discharge the flue gas out of the first member; and a second member including:
      a body extending from the body toward the first member and having an opening fitted around the first member so that the outlet of the first member is positioned within the body of the second member and a flow passage is formed between the first member and the body of the second member;
   an outlet connectable to a chimney side of the flue pipe;
   a mixing chamber formed between the outlet of the first member and the outlet of the second member to receive the flue gas discharged from the outlet of the first member; and
   at least one louver extending through the body to draw the dilution air into the second member so that the dilution air flows through the flow passage and at least partially mixes with the flue gas in the mixing chamber before being discharged to the chimney side of the flue pipe through the outlet of the second member with the flue gas.

2. The device of claim 1, wherein the second member includes a plurality of louver extending through the body thereof.

3. The device of claim 2, wherein the louver are positioned below the mixing chamber.

4. The device of claim 2, wherein the louver are positioned proximate a bottom portion of the first member.

5. The device of claim 2, wherein the body of the second member has four side surfaces and no louver are provided on at least one of the four side surfaces.

6. The device of claim 1, wherein the outlet of the second member is sized to fit inside the chimney side of the flue pipe.

7. The device of claim 1, wherein the mixing chamber is an open space laterally defined by the body.

8. The device of claim 1, wherein the cross sectional area of the mixing chamber is greater than the cross sectional area of the outlet of the second member.

9. The device of claim 1, wherein the cross sectional area of the body is greater than any cross sectional area of the first member.

10. The device of claim 1, wherein the outlet of the second member is spaced apart from the outlet of the first member by at least 1.44 inches.

12. A device for drawing dilution air into a flue pipe extending from a furnace toward a chimney, comprising:
   a first member including:
      an inlet connectable to a furnace side of the flue pipe to receive flue gas therefrom; and
      an outlet to discharge the flue gas out of the first member; and a second member including:
      a body disposed around the first member and containing the outlet of the first member therein;
      an outlet connectable to a chimney side of the flue pipe;
      a mixing chamber formed between the outlet of the first member and the outlet of the second member to receive the flue gas discharged from the outlet of the first member, the mixing chamber being an open space laterally defined by the body; and
a plurality of louvers extending through the body and positioned below the mixing chamber to draw the dilution air into the second member so that the dilution air at least partially mixes with the flue gas in the mixing chamber before being discharged to the chimney side of the flue pipe through the outlet of the second member with the flue gas.

13. The device of claim 12, wherein the cross sectional area of the mixing chamber is greater than the cross sectional area of the outlet of the second member.

14. The device of claim 12, wherein the plurality of louvers are positioned in a bottom half of the second member and below the outlet of the first member.

15. The device of claim 14, wherein the body is a square pipe having four side surfaces and no louvers are provided on at least one of the four side surfaces.

16. The device of claim 12, wherein the cross sectional area of the body is greater than any cross sectional area of the first member.

17. The device of claim 12, wherein the outlet of the second member is spaced apart from the outlet of the first member by at least 1.44 inches.

18. The device of claim 12, wherein the outlet of the second member is sized to fit inside the chimney side of the flue pipe.

19. A device for drawing dilution air into a flue pipe extending from a furnace toward a chimney, comprising:

   a first member including:
   an inlet connectable to a furnace side of the flue pipe to receive flue gas therefrom;
   an outlet to discharge the flue gas out of the first member; and
   a tapered portion between the inlet and outlet, tapering inwardly toward the outlet; and

a second member including:

   a body disposed around the first member and containing the outlet of the first member therein;
   an outlet connectable to a chimney side of the flue pipe;
   a mixing chamber formed between the outlet of the first member and the outlet of the second member to receive the flue gas discharged from the outlet of the first member and having a cross sectional area greater than the outlet of the second member; and
   at least one louver extending through the body at a position below the outlet of the first member to draw the dilution air into the second member so that the dilution air at least partially mixes with the flue gas in the mixing chamber before being discharged to the chimney side of the flue pipe through the outlet of the second member with the flue gas.

20. The device of claim 19, wherein the second member includes a plurality of louvers extending through the body thereof, each of the louvers being formed in a bottom half of the second member.

21. The device of claim 20, wherein the body is a square pipe having four side surfaces and no louvers are provided on at least one of the four side surfaces.

22. The device of claim 19, wherein the cross sectional area of the body is greater than any cross sectional area of the first member.

23. The device of claim 19, wherein the outlet of the second member and the outlet of the first member is spaced apart by at least 1.44 inches.

24. The device of claim 19, wherein the outlet of the second member is sized to fit inside the chimney side of the flue pipe.