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(54) COMBUSTION BURNER ASSEMBLY HAVING LOW OXIDES OF NITROGEN EMISSION

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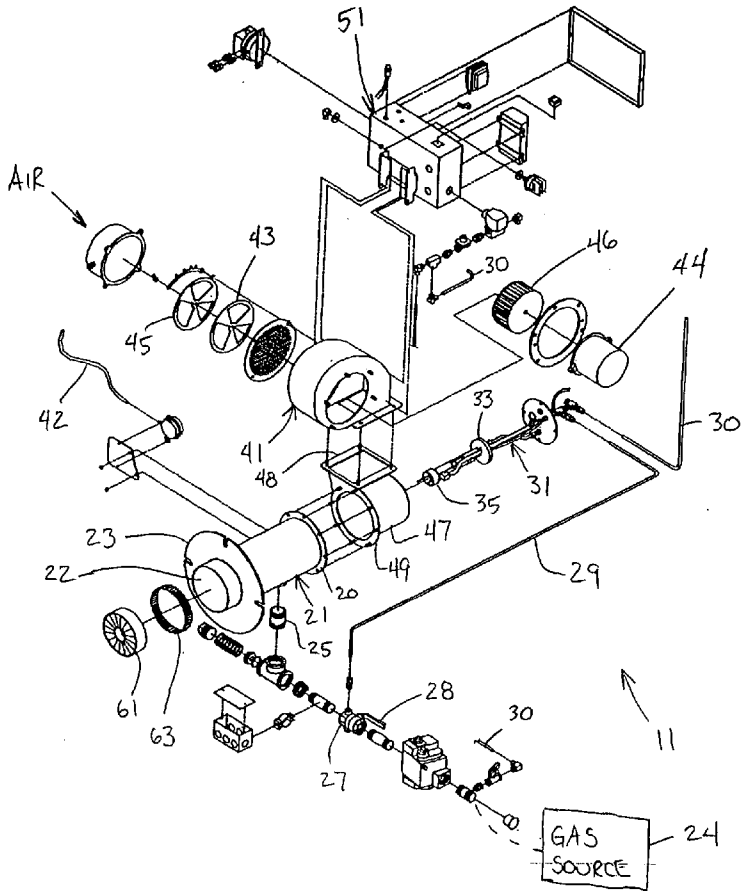
(52) **U.S. Cl.** **431/352**

(57) **ABSTRACT**

A combustion burner assembly having low oxides of nitrogen emission includes a mixing section having an air inlet, a fuel inlet and a fuel mixture outlet. Air is tangentially supplied to the mixing section through the air inlet. A pocket portion in the mixing section receives fuel from a fuel inlet. A plurality of holes in the pocket portion transfer fuel to the mixing section to form a fuel mixture with the air in the mixing section. A diffuser is disposed within the mixing section adjacent the fuel mixture outlet. The diffuser has a plurality of overlapping vanes disposed around an aperture that form a plurality of passages between each of the plurality of overlapping vanes through which the fuel mixture exits the mixing section. A pilot assembly is substantially disposed within the mixing section and passes through the aperture in the diffuser. The pilot assembly is adapted to produce a pilot light downstream of the diffuser that ignites the exiting fuel mixture to produce a high swirling flame, thereby resulting in a combustion burner assembly having low oxides of nitrogen emission.



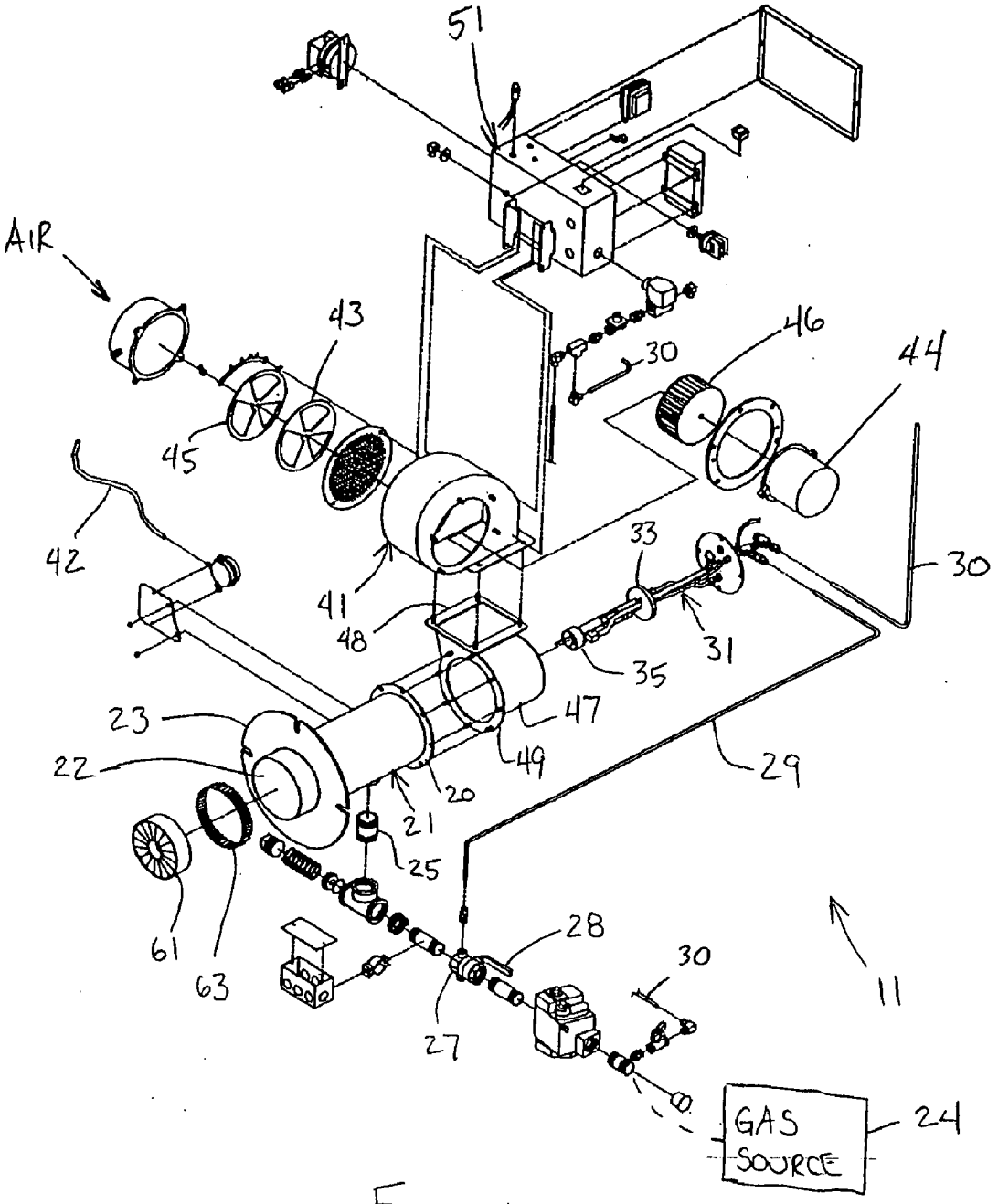

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FIG. 1

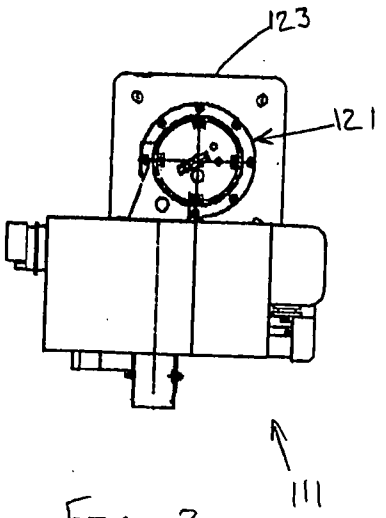

FIG. 2

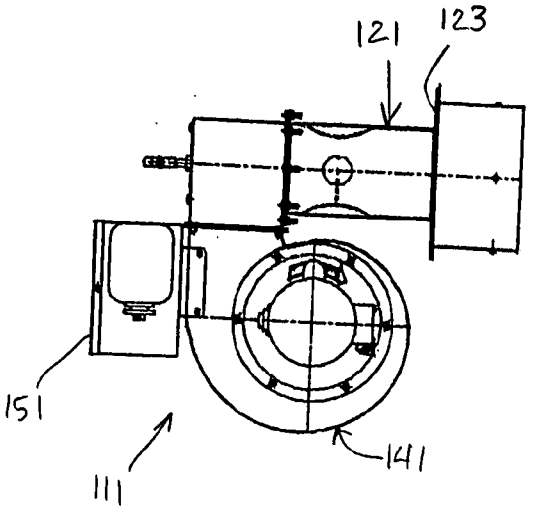

FIG. 3

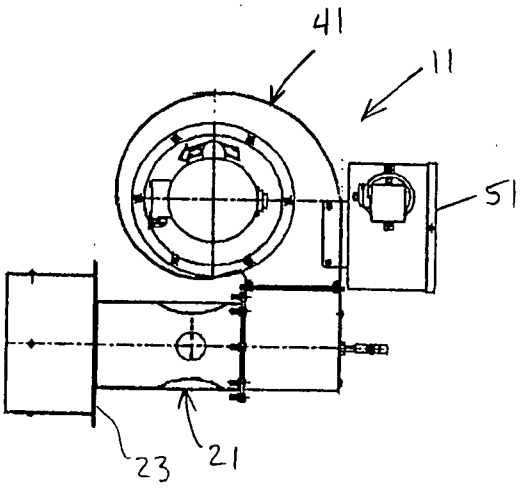

FIG. 4

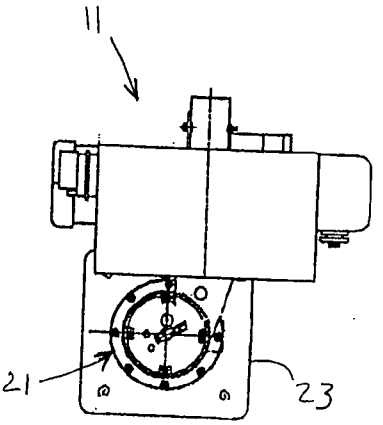

FIG. 5

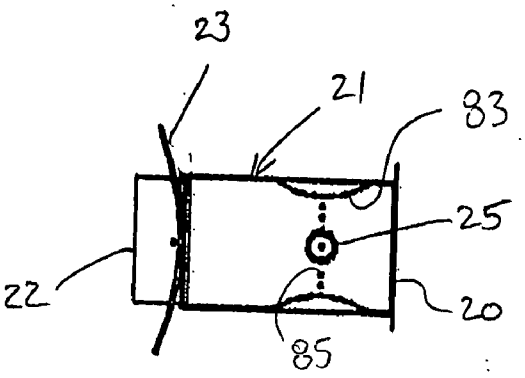

FIG. 6

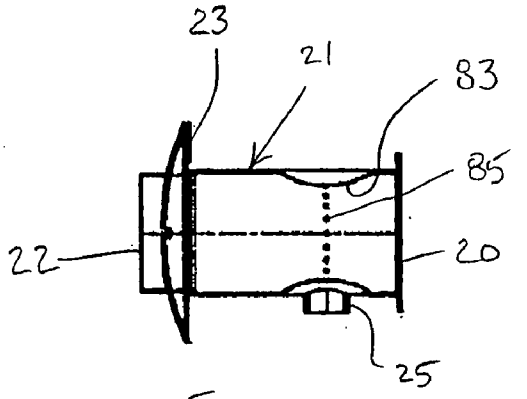

FIG. 7

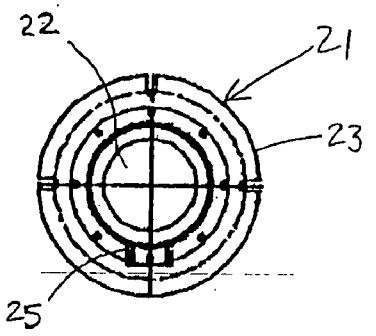

FIG. 8

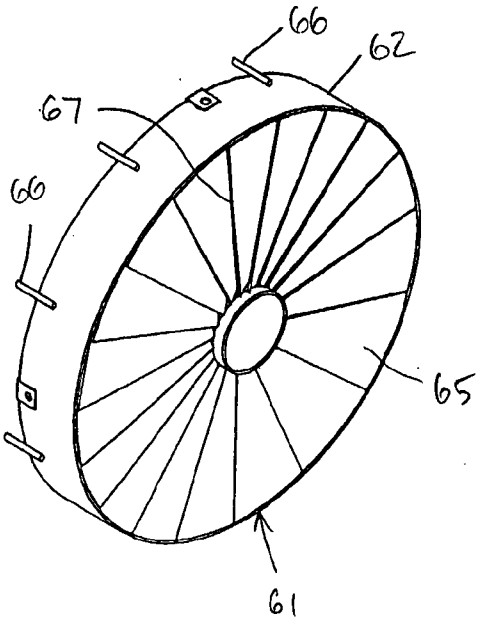

FIG. 9

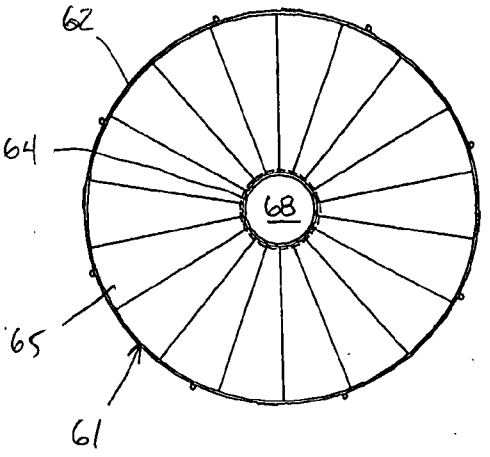

FIG. 10

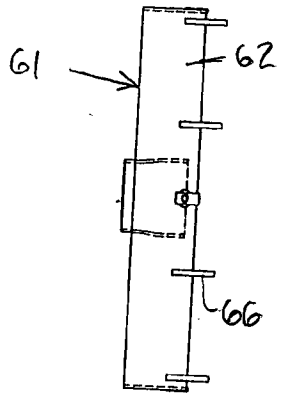

FIG. 11

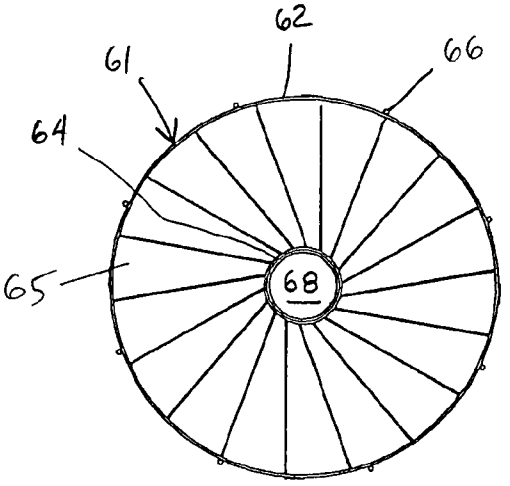

FIG. 12

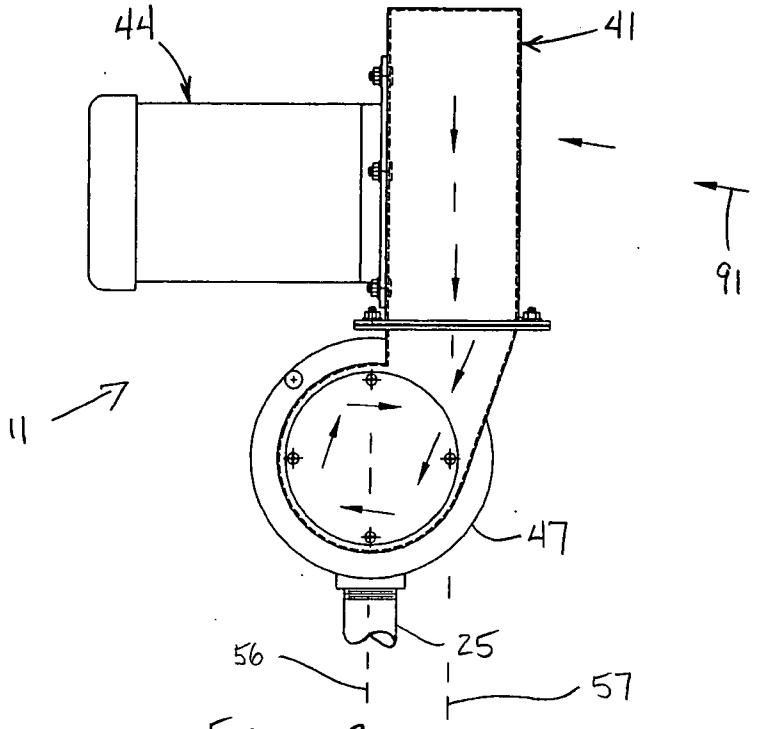
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FIG. 13

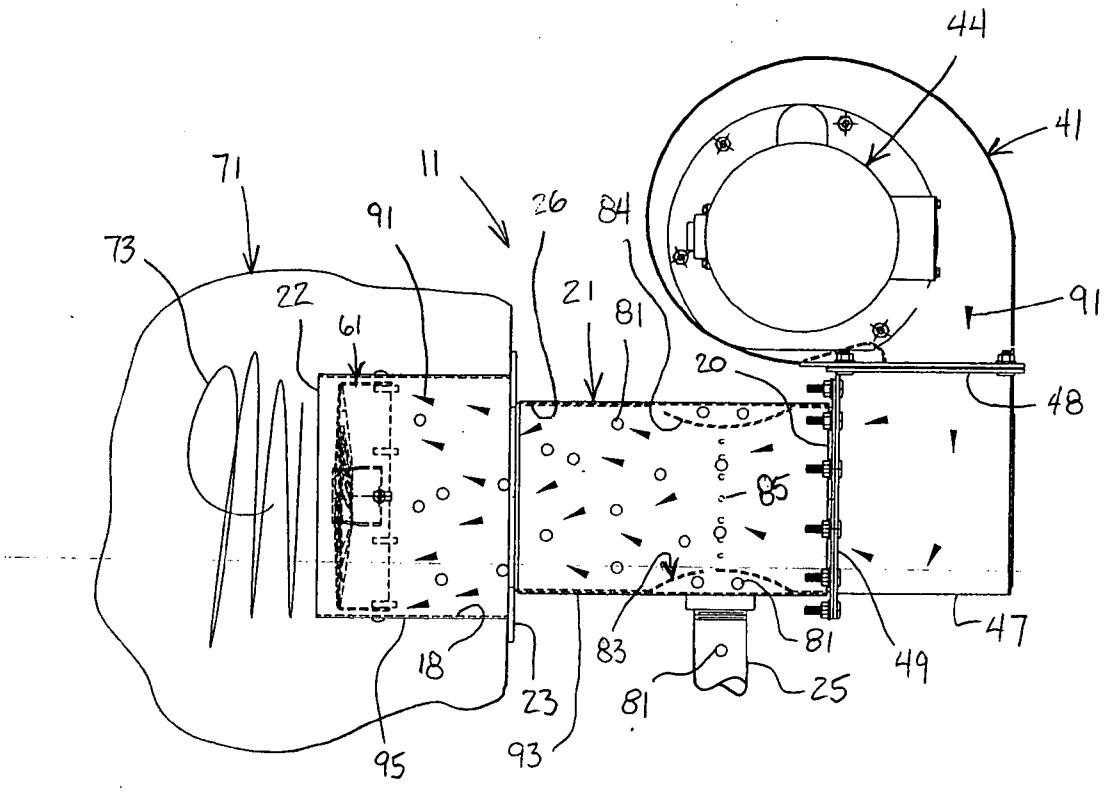
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FIG. 14

COMBUSTION BURNER ASSEMBLY HAVING LOW OXIDES OF NITROGEN EMISSION

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit under 35 U.S.C. §119(e) of provisional application Ser. No. 60/560,351, filed Apr. 8, 2004, which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to a combustion burner assembly providing low oxides of nitrogen emission. More particularly, the present invention relates to non-flue gas recirculating burner assembly that pre-mixes air and gas to provide a stable flame with low oxides of nitrogen emission. Still more particularly, the present invention relates to a mixing section of a combustion burner assembly that premixes air and gas to provide a uniform fuel mixture prior to combustion. The combustion burner assembly provides a uniform and lean fuel mixture to reduce flame temperatures and retard oxides of nitrogen emission.

BACKGROUND OF THE INVENTION

[0003] One problem with existing combustion burner assemblies is the emission of oxides of nitrogen, which are detrimental to the environment. Oxides of nitrogen have been found to be one of the primary causes of acid rain, a highly damaging result of the release of sulfur and oxides of nitrogen. Acid deposition has a variety of effects, including damage to forests and soils, fish and other living things, materials, and human health. U.S. Pat. No. 5,275,554 to Faulkner, the disclosure of which is hereby incorporated by reference in its entirety, discusses the emission of oxides of nitrogen by combustion burner assemblies.

[0004] Another problem with existing combustion burners is the use of a perforated screen or sheet at the fuel mixture exit of the combustion burner. The openings in the sheet, which are generally small, are prone to being plugged by air borne particulates, such as lint. Filters must be used to prevent the screens from capturing lint. The filters must be replaced frequently to maintain the efficiency of the burner. The sheets are also prone to harmonics generated as the fuel mixture passes through the openings, which sounds like a loud fog horn. Those harmonics provide a noisy burner that is a nuisance to those working in the vicinity. A need exists for a burner assembly that does not require a filter and does not create loud harmonics during operation.

[0005] A need exists for an improved combustion burner assembly that reduces oxides of nitrogen emission.

SUMMARY OF THE INVENTION

[0006] Accordingly, it is a primary objective of the present invention to provide an improved combustion burner assembly.

[0007] Accordingly, it is another objective of the present invention to provide a combustion burner assembly that provides low levels of oxides of nitrogen emission.

[0008] Accordingly, it is another objective of the present invention to provide a non-flue gas recirculating combustion burner that provides low levels of oxides of nitrogen emission.

[0009] Accordingly, it is another objective of the present invention to provide mixing section of a burner assembly that premixes air and gas prior to combustion to provide a uniform fuel mixture.

[0010] The foregoing objects are basically attained by providing a combustion burner assembly including a mixing section having an air inlet, a fuel inlet and a fuel mixture outlet. Air is tangentially supplied to the mixing section through the air inlet. A pocket portion in the mixing section receives fuel from a fuel inlet. A plurality of holes in the pocket portion transfer fuel to the mixing section to form a fuel mixture with the air in the mixing section. A diffuser is disposed within the mixing section adjacent the fuel mixture outlet. The diffuser has a plurality of overlapping vanes disposed around an aperture that form a plurality of passages between each of the plurality of overlapping vanes through which the fuel mixture exits the mixing section. A pilot assembly is substantially disposed within the mixing section and passes through the aperture in the diffuser. The pilot assembly is adapted to produce a pilot light downstream of the diffuser that ignites the exiting fuel mixture to produce a high swirling flame, thereby resulting in a combustion burner assembly having low oxides of nitrogen emissions.

[0011] The foregoing objects are also basically attained by providing a method of producing a combustion flame having low oxides of nitrogen emission. Air is supplied tangentially to a mixing section of the burner assembly to create swirling air flow within the mixing section. Fuel is supplied to the swirling air in the mixing section to form a premixed, swirling fuel mixture. A pilot assembly is ignited to produce a pilot light downstream of an exit of the mixing section. The premixed, swirling fuel mixture is passed through a diffuser in the mixing section upstream of the pilot light to spread out the fuel mixture. A combustion flame low in oxides of nitrogen emission is formed by discharging the premixed fuel mixture proximal the pilot light.

[0012] Other objects, advantages and salient features of the invention will become apparent from the following detailed description, which, taken in conjunction with the annexed drawings, discloses preferred embodiments of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Referring now to the drawings that form a part of the original disclosure:

[0014] **FIG. 1** is an exploded perspective view of a burner assembly according to a first embodiment of the present invention;

[0015] **FIG. 2** is a front elevational view of a burner assembly according to a second embodiment of the present invention;

[0016] **FIG. 3** is a side elevational view of the burner assembly of **FIG. 2**;

[0017] **FIG. 4** is a front elevational view of the burner assembly of **FIG. 1**;

[0018] **FIG. 5** is a side elevational view of the burner assembly of **FIG. 4**;

[0019] **FIG. 6** is a side elevational view of the mixing section of the burner assembly of **FIG. 1**;

[0020] **FIG. 7** is a side elevational view of the mixing section of **FIG. 6** rotated so that a gas inlet is extending downwardly;

[0021] **FIG. 8** is a front elevational view of the mixing section of **FIG. 7**;

[0022] **FIG. 9** is a perspective view of a diffuser

[0023] **FIG. 10** is a front elevational view of the diffuser of **FIG. 9**;

[0024] **FIG. 11** is side elevational view of the diffuser of **FIG. 9**;

[0025] **FIG. 12** is a rear elevational view of the diffuser of **FIG. 9**;

[0026] **FIG. 13** is a front elevational diagrammatic view of the air flow entering the blower housing and the mixing chamber of a burner assembly according to a first embodiment of the present invention; and

[0027] **FIG. 14** is a side elevational diagrammatic view of the air and gas flow in the mixing chamber of a burner assembly according to a first embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0028] As shown in **FIGS. 1-14**, a burner assembly **11** according to the present invention reduces the level of oxides of nitrogen emission. A uniform and lean fuel mixture is provided that reduces the combustion flame temperature, thereby resulting in the reduction of oxides of nitrogen (NO_X) emission.

[0029] The burner assembly **11** includes a mixing section **21** in which supplied air and fuel are premixed before being combusted in a heat exchanger **71** (**FIG. 14**). The burner assembly is rigidly coupled to the heat exchanger **71** by flange **23** at a combustion exit **22** of the mixing section **21**, thereby positioning the combustion exit **22** of the mixing section within the heat exchanger. Preferably, the air inlet **20** is at a first end of the mixing section **21** that is opposite the fuel mixture (combustion) exit **22** at a second end of the mixing section. Fuel inlet **25** is preferably positioned between the first and second ends **20** and **22** of the mixing section **21**, as shown in **FIG. 14**. Preferably, the mixing section **21** has a first portion **93** and a second portion **95**. As shown in **FIG. 14**, the first portion **93** has a smaller width than the second portion **95**, although the widths of the first and second portions may be substantially the same, or the width of the first portion may be larger than the width of the second portion. The first portion **93** has an inner surface **26**. The second portion **95** has an inner surface **18**. Preferably, the mixing section **21** is substantially cylindrical and has a flange **23** disposed at the transition from the first portion **93** to the second portion **95**.

[0030] Fuel **81** from an independent source **24** is supplied to the mixing section **21** through fuel (or gas) inlet **25**, as shown in **FIG. 14**. The path of the fuel **81** through the burner assembly **11** is represented in **FIG. 14** by the open circles. The fuel **81** may be natural gas or liquid propane, but any suitable gas may be used. Flow control valve **27** controls the supply of gas from the gas source **24** to the burner assembly **11**, as shown in **FIG. 1**. Handle **28** on the flow control valve **27** stops the supply of gas from the gas source **24**. Fuel **81** is supplied to the mixing section **21** through fuel inlet **25**. Preferably, the fuel inlet **25** is disposed between the first end **20** and the second end **22** of the mixing section **21**.

[0031] Fuel is also supplied through first fuel pilot tubing **29** from the flow control valve to a pilot assembly **31**. Fuel is also supplied to the pilot assembly **31** through second fuel pilot tubing **30**. Providing additional fuel to the pilot assembly **31** enlarges the pilot light, thereby providing a rapid and smooth ignition of the fuel mixture in the mixing section **21**.

[0032] Air **91** is drawn into the burner assembly **11** through an air damper assembly **41**, as shown in **FIGS. 1, 13** and **14**. The path of the air **91** through the burner assembly **11** in **FIGS. 13 and 14** is represented by the solid triangles. Motor **44** drives fan **46** to draw air into the air damper assembly (or blower housing) **41**. First and second louvers **43** and **45** provide accurate control of the intake air, thereby controlling the fuel-air ratio. Air from the air damper assembly **41** is supplied to the mixing section **21** through adapter assembly **47**. The adapter assembly **47** has a first end **48** rigidly coupled to the air damper assembly **41** and a second end **49** rigidly coupled to an intake end (or air inlet) **20** of the mixing section **21** to provide air **91** to the mixing section. The first end (inlet) **48** of the adapter assembly is offset from the second end (outlet) **49**, thereby introducing the air **91** tangentially to the mixing section **21**, as shown in **FIGS. 1 and 13**. A first vertical centerline **56** of the adapter assembly **47** is laterally offset from a second vertical centerline **57** through the air damper assembly **41**, as shown in **FIG. 13**. The air **91** entering the mixing section **21** tangentially causes the air to spin, as shown by the solid triangles in **FIG. 13**, thereby swirling the air within the mixing section. The premixing of the air and fuel is facilitated by adding the fuel to the swirling air. Air **91** from the air damper assembly **41** is also supplied to the pilot assembly **31** through pilot air tubing **42**.

[0033] The fuel inlet **25** supplies fuel to a pocket portion **83** of the mixing section **21**, as shown in **FIGS. 6, 7** and **14**. The pocket portion **83** preferably extends entirely around the perimeter of the inner surface **26** of the mixing section **21**. A plurality of holes **85** in an outer wall **84** of the pocket portion **83** allow the supplied fuel **81** to pass from the pocket portion **83** into the mixing section **21** to form a premixed fuel mixture with the supplied air **91**.

[0034] Control panel **51** of the burner assembly **11** houses the burner operating controls, such as controls for supplying power to the motor **44** and the pilot assembly **31**.

[0035] The pilot assembly **31** receives fuel from both the first and second fuel pilot tubing **29** and **30**, as well as receiving air through pilot air tubing **42**. The air and fuel (i.e., the fuel mixture) supplied to the pilot assembly **31** are premixed to improve light-off reliability and stability of the combustion flame. The pilot assembly **31** is positioned within the mixing section **21**. The pilot assembly may include disk **33** to promote a low pressure zone in the mixing section **21**, thereby facilitating thorough mixing of the air supplied through adapter assembly **47** and fuel supplied through inlet **25**, as well as reducing the required pressures of the supplied fuel. The reduction in pressure results in increased velocity, which facilitates premixing of the air and fuel. Once the pilot assembly **31** has been ignited through the control panel **51**, the thoroughly mixed fuel mixture is

combusted and exhausted through the combustion exit (or fuel mixture outlet) **22** into the heat exchanger **71**. A high swirling flame **73** is produced that increases recirculation and stability.

[**0036**] Premixing the supplied air and fuel mixture in the mixing section **21** ensures complete combustion of the fuel mixture with minimal levels of carbon monoxide and unburned hydrocarbons. The diffuser **61** and band **63** provided in the mixing section **21** facilitate reliable and consistent performance at the operating conditions necessary to provide low oxides of nitrogen emission. The diffuser **61** and band **63** facilitate mixing of the fuel **81** and air **91** in forming the fuel mixture, as well as providing a high swirl of the fuel mixture to provide enhanced flame retention. The diffuser **61** and band **63** also prevent flashback of the combustion flame into the mixing section **21** from the heat exchanger, which is a problem with existing combustion burners. The diffuser **61** may be used without the band **63**.

[**0037**] The diffuser **61**, as shown in **FIGS. 9-12** preferably has eighteen blades **65**. The blades overlap, preferably by about 50% of the blade width, to form a narrow passage **67** between the blades **65** through which the fuel mixture exits the burner assembly **11**. The narrow and deep passages **67** prevent combustion flame flashback. Due to the overlapping of the blades **65**, larger passages **67** are able to be created to eliminate clogging or plugging of the passages with airborne particulates. Additionally, the flame front is stabilized by the high swirl generated by the diffuser **61** so that the burner assembly **11** is not prone to harmonic noise associated with existing burner assemblies.

[**0038**] The diffuser **61** has an outer member **62** and an inner member **64**, as shown in **FIGS. 9-12**. The inner member **64** of the diffuser **61** forms an aperture **68**. The plurality of vanes **67** extend between the inner member **64** and the outer member **62** of the diffuser **61**. Preferably, the outer and inner members **62** and **64** are substantially circular, as shown in **FIGS. 10 and 12**. The ignition end **35** of the pilot assembly **31** passes through the aperture **68** in the diffuser **61**, as shown in **FIG. 1**, such that the pilot light created by the pilot assembly **31** is formed downstream of the diffuser. For reasons of clarity, the pilot assembly **31** is not shown in **FIGS. 13 and 14**. The swirling, pre-mixed fuel mixture passes through the diffuser **61** at the fuel mixture outlet **22** of the mixing section **21**. The fuel mixture is ignited by the pilot light as it passes through the diffuser **61** by the pilot light to create a flame **73**. The swirling motion of the exiting fuel mixture results in a high swirling flame **73** that increases recirculation and flame stability.

[**0039**] The diffuser **61** is preferably rigidly fixed to the inner surface **18** of the exhaust portion **19** of the mixing section **21**, as shown in **FIGS. 1 and 14**. Spacers may be disposed on the outer surface **62** of the diffuser **61** to space the diffuser from the inner surface **18** of the exhaust portion **19** of the mixing section **21** to prevent flashback into the mixing section. The spacers may be rods **66** affixed to the outer surface **62** of the diffuser, as shown in **FIGS. 9-12**, to maintain the gap between the diffuser and the inner surface **18** of the exhaust portion **19** of the mixing section. Alternatively, raised dimples (not shown) on the outer surface **62** of the diffuser **61** may be used to space the diffuser from the inner surface **18** of the exhaust portion **19** of the mixing section **21**.

[**0040**] The mixing section **21**, or venturi section, premixes the supplied fuel **81** and air **91** to form an extremely uniform and lean fuel mixture, thereby providing uniform flame temperatures. The fuel mixture being uniform and lean reduces the combustion flame temperature, thereby reducing the oxides of nitrogen emission of the combustion burner assembly **11**. Furthermore, the mixing section **21** reduces the required pressure of supplied fuel **81**, which facilitates drawing fuel in from inlet **25** to be mixed with the supplied air **91** from the adapter assembly **47**. The disk **33** disposed on the pilot assembly **31** is positioned proximal the injection point of the fuel **81** into the mixing section **21** to reduce the pressure within the mixing chamber, thereby increasing the velocity of both the supplied air and fuel. The disk **33** on the pilot assembly reduces the amount of open area in the mixing section **21**, thereby reducing the pressure therein. The increased fuel mixture velocity provides a fuel mixture velocity larger than the flame speed velocity, which also facilitates flashback prevention. Furthermore, the depth of the gap (i.e., the width of the diffuser and/or the air band) and the cool temperature of the fuel mixture, maintain a cool air band (if used) and mixing section. If the combustion flame was to migrate upstream, the combustion flame would be cooled below its ignition temperature and quenched.

[**0041**] The second embodiment of the combustion burner assembly **111**, as shown in **FIGS. 2 and 3**, is substantially similar to the first embodiment of the combustion burner assembly **11**, as shown in **FIGS. 1 and 4-8**. The operation of the burner assembly **111** is substantially similar to that of the first embodiment of the burner assembly **11**. The part numbers referred to in the second embodiment of the burner assembly **111** are similar to that of the first embodiment of the burner assembly **11**, but the part numbers of the second embodiment are **100** larger than the first embodiment. The first embodiment of the burner assembly **11** is useful in applications requiring a low centerline, thus the mixing section **21** being positioned below the air damper assembly **41**, as shown in **FIG. 4**. The second embodiment of the burner assembly **111** is useful when a low centerline is not required, thus the air damper assembly **141** being positioned below the mixing section **121**, as shown in **FIG. 2** and **3**.

[**0042**] While advantageous embodiments have been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A combustion burner assembly, comprising:

a mixing section having an air inlet, a fuel inlet and a fuel mixture outlet, said air inlet supplying air tangentially to said mixing section;

a pocket portion in said mixing section to receive fuel from said fuel inlet;

a plurality of holes in said pocket portion to transfer fuel to said mixing section to form a fuel mixture with said air in said mixing section;

a diffuser disposed within said mixing section adjacent said fuel mixture outlet, said diffuser having a plurality of overlapping vanes disposed around an aperture forming a plurality of passages between each of said

plurality of overlapping vanes through which said fuel mixture exits said mixing section; and

a pilot assembly substantially disposed within said mixing section and passing through said aperture in said diffuser, said pilot assembly adapted to produce a pilot light downstream of said diffuser to ignite said fuel mixture.

2. A combustion burner assembly according to claim 1, wherein

said mixing section having a first end and a second end, said first end being said air inlet, said second end being said fuel mixture outlet.

3. A combustion burner assembly according to claim 2, wherein

said first end is opposite said second end.

4. A combustion burner assembly according to claim 3, wherein

said fuel inlet is positioned between said first end and said second end of said mixing section.

5. A combustion burner assembly according to claim 1, wherein

said pilot assembly has a first tube supplying air and a second tube supplying fuel to produce the pilot light.

6. A combustion burner assembly according to claim 1, wherein

each of said plurality of vanes has a width, each of said plurality of vanes overlapping by approximately half of said width.

7. A combustion burner assembly according to claim 1, wherein

a plurality of spacers are disposed on an outer surface of said diffuser to space said diffuser from an inner surface of said mixing section.

8. A combustion burner assembly according to claim 7, wherein

said plurality of spacers are a plurality of rods.

9. A combustion burner assembly according to claim 7, wherein

said plurality of spacers are a plurality of dimples.

10. A combustion burner assembly according to claim 1, wherein

a disk is disposed on said pilot assembly to reduce pressure within said mixing chamber to increase the velocity of the fuel mixture.

11. A combustion burner assembly according to claim 10, wherein

said disk is disposed on said pilot assembly proximal said plurality of holes in said pocket portion.

12. A combustion burner assembly according to claim 1, wherein

an air band is disposed around an outer surface of said diffuser to prevent flashback into said mixing section.

13. A combustion burner assembly according to claim 1, wherein

an air damper supplies air to said air inlet of said mixing section, said air damper being positioned above said mixing section.

14. A combustion burner assembly according to claim 1, wherein

an air damper supplies air to said air inlet of said mixing section, said air damper being positioned below said mixing section.

15. A combustion burner assembly according to claim 1, wherein

a flange is disposed on an outer surface of mixing section, said flange being adapted to be rigidly secured to a heat exchanger.

16. A combustion burner assembly, comprising:

a mixing section having a first end and a second end;

an adapter assembly connected to said first end of said mixing section;

an air damper connected to said air adapter, air being tangentially supplied to said adapter assembly to create swirling air flow through said mixing section;

a pocket portion in said mixing section to receive fuel from a fuel inlet;

a plurality of holes in said pocket portion to transfer fuel to said mixing section to form a swirling, premixed fuel mixture with said air in said mixing section;

a diffuser disposed within said mixing section adjacent said second end of said mixing section, said diffuser having a plurality of overlapping vanes disposed around an aperture forming a plurality of passages between each of said plurality of overlapping vanes through which said fuel mixture exits said second end of said mixing section; and

a pilot assembly substantially disposed within said mixing section and passing through said aperture in said diffuser, said pilot assembly adapted to produce a pilot light downstream of said diffuser to ignite said exiting fuel mixture.

17. A combustion burner assembly according to claim 16, wherein said first end is opposite said second end.

18. A combustion burner assembly according to claim 16, wherein said fuel inlet is positioned between said first end and said second end of said mixing section.

19. A combustion burner assembly according to claim 16, wherein said pilot assembly has a first tube supplying air and a second tube supplying fuel to produce the pilot light.

20. A combustion burner assembly according to claim 16, wherein each of said plurality of vanes has a width, each of said plurality of vanes overlapping by approximately half of said width.

21. A combustion burner assembly according to claim 16, wherein a plurality of spacers are disposed on an outer surface of said diffuser to space said diffuser from an inner surface of said mixing section.

22. A combustion burner assembly according to claim 21, wherein said plurality of spacers are a plurality of rods.

23. A combustion burner assembly according to claim 21, wherein said plurality of spacers are a plurality of dimples.

24. A combustion burner assembly according to claim 16, wherein a disk is disposed on said pilot assembly to reduce pressure within said mixing chamber to increase the velocity of said fuel mixture.

25. A combustion burner assembly according to claim 24, wherein said disk is disposed on said pilot assembly proximal said plurality of holes in said pocket portion.

26. A combustion burner assembly according to claim 16, wherein an air band is disposed around an outer surface of said diffuser to prevent flashback into said mixing section.

27. A combustion burner assembly according to claim 16, wherein said air damper is positioned above said mixing section.

28. A combustion burner assembly according to claim 16, wherein said air damper is positioned below said mixing section.

29. A combustion burner assembly according to claim 16, wherein a flange is disposed on an outer surface of mixing section, said flange being adapted to be rigidly secured to a heat exhanger.

30. A method of producing a combustion flame having low oxides of nitrogen emission, comprising the steps of:

supplying air tangentially to a mixing section of the burner assembly to create swirling air flow within the mixing section;

supplying fuel to the swirling air in the mixing section to form a premixed, swirling fuel mixture;

igniting a pilot assembly to produce a pilot light downstream of an exit of the mixing section;

passing the premixed, swirling fuel mixture through a diffuser in the mixing section upstream of the pilot light to spread out the fuel mixture; and

forming a combustion flame low in oxides of nitrogen emission by discharging the fuel mixture proximal the pilot light.

31. The method of producing a combustion flame having low oxides of nitrogen emission of claim 30, further comprising

increasing the velocity of the fuel mixture by decreasing the pressure within the mixing section by disposing a disk on the pilot assembly.

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