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(54) GAS-FIRED HEATERS WITH BURNERS WHICH OPERATE WITHOUT SECONDARY AIR

GASHEIZOFEN MIT BRENNERN DIE OHNE ZUSATZLUFT FUNKTIONIEREN

DISPOSITIF DE CHAUFFAGE AU GAZ COMPRENANT DES BRULEURS FONCTIONNANT SANS AIR SECONDAIRE

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- **PATENT ABSTRACTS OF JAPAN vol. 008, no. 020 (M-271), 27 January 1984 & JP 58 179715 A (MATSUSHITA DENKI SANGYO KK), 21 October 1983,**

EP 0 619 007 B9

Description

TECHNICAL FIELD

[0001] The present invention relates to heaters and in particular to gas fired heaters.

[0002] The invention has been developed primarily for use as a water heater, room heater or the like and will be described hereinafter with reference to these applications. However, it will be appreciated that the invention is not limited to these particular fields of use.

[0003] The present invention relates more particularly to gas-fired heaters having a gas-fired burner in which the combustion occurs at or near a combustion surface maintained at subatmospheric pressure. The burner is operated at conditions which result in primarily convective heat transfer and reduced emissions of oxides of nitrogen (NO_x) and carbon monoxide (CO).

[0004] Two embodiments of this invention are illustrated. One embodiment provides a novel and improved water heater in which improved performance is obtained by providing the combustion surface in a sealed combustion chamber maintained at subatmospheric pressure without the use of powered mechanical fans or blowers. A second embodiment provides a novel and improved space heater in which the combustion surface of the burner is maintained at subatmospheric pressure and is arranged for direct heat transfer to the surrounding space to be temperature conditioned.

BACKGROUND ART

[0005] It has now been established that gas burners of all kinds are known to be a source of indoor pollution especially in the amounts of oxides of nitrogen (NO_x) formed.

[0006] NO_x is a term used to describe the combined "Oxides of Nitrogen" and in particular to NO, N_2O and NO_2. For example NO and N_2O are a concern in the outdoor environment, in particular with relation to acid rain, ozone and photochemical smog. NO_2 is similarly a major concern to medical authorities due to its effect on lung function. This has led to severe restrictions on the acceptable emission levels of NO_x with particular emphasis on the emission of NO_2.

[0007] The exact amount of air needed to provide complete combustion of a given amount of fuel is the stoichiometric amount of air, and the stoichiometric ratio is said to be 1. The ratio of air to fuel must equal or exceed the stoichiometric ratio if combustion is to be complete. If the primary air flow is at least the stoichiometric amount, then theoretically no additional or secondary combustion air is required for complete combustion. Secondary combustion air generally complicates the combustion process, leading to nonuniform combustion areas, hotter or cooler than the average. Such non-uniformity of combustion leads to localized production of undesirable combustion products, particularly carbon monoxide (CO) and the oxides of nitrogen (NO_x).

[0008] Gas-fired space heaters utilizing primarily convective heat transfer must circulate the heated air at a sufficiently low temperature to avoid injury or damage while also maintaining the comfort of room occupants. In the case of direct heat transfer, the circulated heated air has heretofore been diluted with cooler room air passed through the heater as secondary combustion air. However, the use of secondary combustion air generally complicates the combustion process and results in the emission of higher levels of pollutants.

[0009] There are numerous prior art gas burners for water heaters of which two such examples are those disclosed in US patents 4,510,890 (COWAN) and 4,867,106 (STAATS).

[0010] STAATS describes a water heater having an insulated water tank with a flue pipe extending from a combustion chamber housing a blue flame burner located beneath the tank. Baffles are used within the flue to maximise the heat transfer to the fluid in the tank. An exhaust fan is used to help extract the exhaust products from the baffled flue to a direct through-the-wall vent. As this water heater configuration uses a blue flame burner which operates on the combustion of primary and secondary air, it produces high levels of oxides of nitrogen emissions, It is also necessary with such burners to ensure there is adequate access of secondary air to the combustion chamber.

[0011] COWAN by contrast relates to a flued heater structure consisting of a water tank, to a side of which is mounted an infra-red burner which radiates heat at a very high temperature, horizontally, against the side wall of the tank. The burned gases are again conducted upwardly through a flue stack having a plurality of baffles to maximise the heat exchange with the fluid in the tank.

[0012] The improvement of the device disclosed is simply the use of a sidewall mounted infra-red burner to reduce emissions of oxides of nitrogen as compared to water heaters powered by secondary aerated bunsen type burners. However, the infra-red burner uses a restricted venturi and is thereby of a larger than usual size for a given loading and is therefore fairly cumbersome, particularly in its application to the outer side of the tank.

[0013] Similarly, there axe numerous prior art patent applications relating to space heaters. An example of which is Australian Patent Application AU 60654/86 (RINNAI). This application teaches a burner apparatus which is particularly suited to space heaters and which is capable of operating in both a bunsen mode and a full primary combustion mode. The essence of the disclosure relates to a safety mechanism for detecting a state of oxygen deficiency when the burner is in the bunsen type combustion mode. Once again a fairly large conventional sized burner is employed which must be open to secondary air to facilitate the bunsen type combustion. Another example is disclosed in Japanese Patent Application 58-179715.

[0014] It is an object of the present invention to overcome or at least ameliorate one or more of the disadvantages of the prior art.

DISCLOSURE OF THE INVENTION According to a first aspect of the invention there is provided a gas-fired burner apparatus as claimed in claim 1.

[0015] According to a second aspect of the present invention there is provided a room heater according to claim 23.

[0016] According to a third aspect of the present invention there is provided a method according to claim 26.

[0017] According to a development of the invention there is provided a water heater comprising a tank defining a vertically extending generally cylindrical water chamber, a dome shaped upwardly concave wall forming the lower end of said water chamber and the upper surface of a combustion chamber, a flued stack extending vertically along the centre of said water chamber open at its lower end to said combustion chamber through the central portion of said concave wall and at its upper end to the environment above said water chamber, a porous combustion surface located in said combustion chamber, a plenum chamber below said combustion surface, an air duct open to said plenum chamber, and a supply of gaseous fuel connected to said air duct operating to combine with an amount of primary air into said plenum chamber sufficient to establish a greater than stoichiometric mixture, said combustion chamber being substantially sealed except for said air duct and the lower end of said flue stack so that secondary combustion air does not enter said combustion chamber, the combustion gases resulting from combustion of said gaseous fuel and primary air flowing in a substantially uninterrupted manner upwardly along said concave surface to said flue stack and through said flue stack to establish a subatmospheric pressure in said combustion chamber without requiring powered mechanical flow producing devices, said subatmospheric pressure causing a flow of gases through said combustion surface at a rate which exceeds the rate of flow that would exist if the combustion chamber were open to atmospheric pressure whereby the area of the combustion surface is reduced for a given heat energy input and burner rating as compared with the area of the combustion surface required for the same heat energy input and burner rating if the combustion chamber was at atmospheric pressure.

[0018] Desirably the combustion temperature is maintained in the range 600°C to 900°C with a preferable combustion loading of 20% to 400% in excess of the loading produced in the absence of the subatmospheric pressure.

[0019] Preferred embodiments of the invention include a water heater and a room heater each incorporating burner apparatus having the features discussed above.

[0020] A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Figure 1 is a schematic longitudinal sectional view of a water heater having a burner which embodies the invention;
Figure 2 is a schematic plan view of the water heater and burner shown in Fig 1, taken along line 2 - 2 of Figure 1;
Figure 3 is an enlarged fragmentary side elevation of the burner and combustion chamber portion of the unit;
Figure 4 is a schematic vertical section of a space heater embodying the invention; and
Figure 5 is a perspective view of the space heater shown in Figure 4 with parts omitted for clarity of illustration.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0022] Referring to Figure 1, heater 1 includes a gas-fired burner or combustion unit 2 having a combustion surface 5 housed within the base of a water heater 3. The combustion surface 5 is generally horizontally mounted and centered within the base of the water heater.

[0023] As shown in Figure 3, the combustion unit 2 includes a plenum chamber 4 positioned below the burner combustion surface 5 and an air/fuel mixing and delivery device comprising an air duct 7. The air duct may be in the form of a venturi as shown or in the form of a cylindrical tube or pipe. The cross-sectional area of the air duct should be sufficiently large to minimize pressure flow losses relative to the subatmospheric pressure driving force above the combustion surface 5. Gaseous fuel, such as natural gas, enters the air duct 7 from a nozzle 7a and aspirates or induces environmental air to enter the plenum chamber 4 with the fuel. In this manner, the air duct 7 operates in response to the flow of fuel to aspirate and combine environmental air with the fuel to form a combustible air/fuel mixture which is delivered to the plenum chamber 4 at a plenum pressure.

[0024] Nozzle 7a is preferably positioned approximately one inch (25.4 mm) away from the plane of the mouth of the air duct 7. It has been determined that improved results are achieved if the entrance of the air duct is open to the exterior of the heater shell. Further, the air duct allows excessive primary air to mix with the fuel in the plenum 4. The majority of the primary combustion air is provided by the driving force of the subatmospheric pressure maintained above the combustion surface 5.

[0025] Combustion chamber 8 is in fluid communication, via pores in the burner combustion surface 5, with the plenum chamber 4, which in turn is in fluid communication with the air duct 7. Air duct 7 provides at least partial mixing of the air and fuel, which is completed within the plenum chamber 4. The burner combustion surface 5 is a pourous combustion surface. It is preferably made of wire, and is more preferably made of inconel 601 wire. Surface 5 may also be made of other heat resistant porous materials, such as ceramics.

[0026] The burner combustion surface 5 is disposed within a substantially sealed combustion chamber 8. Combustion chamber 8 may enclose the burner element 2, or the burner element 2 may be attached to the bottom wall 12 of the combustion chamber, whereby burner combustion surface 5 constitutes a portion of the inner wall of chamber 8. Chamber 8 is sufficiently sealed to prevent entry into the combustion chamber of secondary air in quantities which could adversely affect burner operation. Flue stack 9 constitutes an opening to the environmental air. Thus, as used here in relation to combustion chambers, "sealed" or "closed" refers to preventing entry of significant quantities of secondary air into the combustion chamber,

[0027] As best shown in Figure 3, flue stack 9 extends vertically upward from an upper dome-shaped wall surface 11 of the combustion chamber 8 through the center of the water tank 10. The flue stack may extend above the water heater to increase the natural draft and further decrease the subatmospheric pressure in the combustion chamber 8. The dome-shaped upper wall 11 functions to guide the combustion products into the flue stack 9. Further, the domed wall 11 operates as a heat exchange surface since it is part of the water tank.

[0028] Flue stack 9 may also contain baffle means (not shown) to improve efficiency of heat transfer from combustion gases to the water. The baffle should be designed to minimise frictional flow losses in the flue stack.

[0029] In a typical water heater in which the lower portion of the combustion chamber is open to environmental air and the burner has been extinguished between heating cycles, cool air is drawn through the combustion chamber and flue stack by the buoyancy of air heated by the hot water contained in the water heater 3. Such air cools the heated water, resulting in passive losses and reduced efficiency.

[0030] By sealing the combustion chamber, entry of such unheated air is substantially prevented. The only exception is a small amount of air passing through the air duct 7. Thus, providing a sealed combustion chamber further reduces passive heat losses by restricting the influx of cool air during interim, shutdown periods.

[0031] Positioned on the lower wall 12 of the combustion chamber 8 is insulation 12a which performs two functions. First, it reduces noise during burner operation, and second, it reduces heat loss through wall 12.

[0032] Air duct 7 is adapted to deliver and at least partially mix air and fuel having an air component at least equal to 110% of the stoichiometric amount. In this embodiment of the present invention, the preferred amount of air mixed with fuel in the air duct exceeds the stoichiometric amount by approximately 20% to 100% in order to lower the combustion temperature and the NO_x emissions to the desired level.

[0033] Excess air is used in the present invention to help maintain the combustion temperature in the range from 600°-900°C, and to assure complete combustion of fuel, thereby to maintain a low level of undesirable emissions from the combustion. The excess air is primary air, since it is mixed with the fuel entering the combustion element via the air duct. Excess air mixed with fuel as primary combustion air acts to reduce the level of undesirable emissions below that obtained when secondary air is allowed to enter.

[0034] At the lower range of excess air (e.g. 10%), the quantity of CO is reduced by providing complete combustion of carbon to CO_2. At the higher range of excess air (e.g. 100%), the combustion temperature is lowered to the point that CO production begins to increase. The excess air inhibits formation of NO_x by maintaining a low combustion temperature. Secondary air, on the other hand, causes a nonuniform combustion process, and results in increased emissions due to resulting hot and cool zones on the combustion surface. Generally, hot zones create excess NO_x; cool zones create excess CO.

[0035] The subatmospheric pressure in the sealed combustion chamber is obtained by the natural draft of the venting of the products of combustion through the flue stack to the atmosphere. The pressure in the combustion chamber in the region above the combustion surface can be described mathematically as:

$$P_{ch} = P_{atm} - [(D_{atm} - D_{fl}) \times H_{fl} \times g] +$$

friction loss where:

P_{ch} = pressure within combustion chamber

P_{atm} = atmospheric pressure
D_{atm} = density of surrounding atmosphere
D_{fl} = flue gas average density
g = gravitational constant
H_{fl} = flue stack height

[0036] Friction loss is generated by the turbulent flow of the hot combustion products buoyantly rising in the flue stack or frictional interactions with the flue stack walls and baffles. Flue stack height is the vertical height of the flue stack from the upper surface of the combustion chamber to the point of discharge to the environment.

[0037] The first embodiment described herein is designed for a residential water heater. Typical water heaters require a baffle in the flue stack to reduce thermal losses and increase efficiency to mandated levels. Frictional losses due to the baffle clearly act to decrease the natural draft effect. Engineering trade-offs between baffle design and burner design must be considered in the application of this invention to water heaters and other uses.

[0038] Preferably the chamber and flue stack are sized to reduce the pressure in the combustion chamber to the lowest possible value obtainable from the natural buoyancy of hot combustion products ventilating through the flue stack, consistent with efficient heat transfer to the medium to be heated.

[0039] The natural draft as described above acts to pull more air through the burner surface than would pass without the particular configuration employed in this invention. The increased air flow increases the percentage of excess air and lowers the combustion temperature and NO_x emissions. An atmospheric pressure driven burner operating without the benefit of such natural draft could not achieve the benefits obtainable from the instant invention. The present result is obtained by increasing the pressure drop across the burner combustion surface. This increased pressure drop is facilitated by the use of the pourous combustion surface 5.

[0040] Instead of using natural draft to increase air flow, the air flow can be held at a desired stoichiometric ratio, and the combustion surface area can be reduced. A smaller combustion surface area, having fewer pores or openings, restricts the flow of air/fuel mixture more than a larger area with more openings. In a smaller element there will be a greater resistance to flow of the same volume of air/fuel mixture. Thus with the present invention the same amount of air and fuel is passed through the smaller area with natural draft being used to overcome the greater resistance to flow. The burner 2 has been demonstrated at a heat input resulting in a combustion loading of 1644 MJ/hr m^2. An equivalent rated burner operating without a sealed combustion chamber in the same water heater producing substantially the same NO_x emissions had a combustion loading of about 500 HJ/hr m^2. In this manner the natural draft effect enables reduction of the combustion surface area by a factor of more than three and results in a significantly lower cost for manufacture of the burner.

[0041] The second embodiment of the present invention provides a room or space heater suitable for unvented, indoor use. Referring to Figure 4, a room heater 20 includes a housing 21. A combustion unit or burner element 23 is mounted in the housing 21 at a position approximately centered from front to back and vertically slightly below the center of the housing 21. Element 23 has an elongate cylindrical shape and extends horizontally through the housing 21. One end of element 23 is closed, while at the opposite end is air duct 24, which provides a combustible air/fuel mixture to element 23. A gaseous fuel is introduced into the air duct 24 through gas supply nozzle 24a.

[0042] The air duct 24 is centrally mounted within the burner element 23 with the plane of the flared circular end of the duct aligned with the end of the burner element. Nozzle 24a is preferably positioned approximately one inch (25.4 mm) away from the plane defined by the flared circular end of the air duct.

[0043] The upper combustion surface 25 of burner element 23 is a porous combustion surface and allows passage of the air/fuel mixture from the air duct 24 through the surface for combustion. Surface 25 is preferably made of wire, and is more preferably made of inconel 601 wire. Surface 25 may also be made of other heat resistant porous materials, such as ceramics.

[0044] The volume inside the cylindrical combustion unit 23 defines a plenum chamber 27. Chamber 27 is in fluid communication with combustion chamber 26 via the pores of surface 25. Chamber 27 is likewise in fluid communication with environmental air and gas supply nozzle 24a via air duct 24.

[0045] The space above the burner surface 25 is enclosed by the wall 33 of the blower channel 30 (as described more fully below) a front wall 34 and axial end walls (not shown), which cooperate to substantially define the combustion chamber 26. The terminal portions of the rear wall 33 and the front wall 34 cooperate to define an elongate combustion chamber discharge opening 31 through which the products of combustion are removed.

[0046] Disposed on one side of heater 20 is an intake vent 28 through which environmental air is drawn. An electric blower 22 is mounted in the housing 21 near the intake vent 28. Blower 22 draws environmental air into the housing 21 and propels the air through channel or passage 30 towards exit vent 29 via an elongated nozzle or orifice 32. The environmental air handled by blower 22 does not participate in combustion of fuel in heater 20. Such air is used for entraining, diluting and then distributing the heat provided by combustion element 23 by aspirating or inducing the flow of combustion gases out of the combustion chamber 26. Blower 22 preferably provides approximately 40 times the amount of air used by the combustion element 23 in combustion of fuel, but this amount may be widely varied depending on the individual needs of the heater user. As the environmental air from blower 22 passes through passage or channel 30, it is forced through discharge nozzle or orifice 32, which produces a downwardly directed jet of air of increased velocity. This high velocity jet of air moving past the discharge opening 31 of the combustion chamber 26 entrains combustion products by aspiration and produces a subatmospheric pressure in chamber 26.

[0047] Several benefits accrue from the provision of this volume of air by operation of the invention. First, the extremely hot combustion gases exiting the combustion chamber 26 are diluted and thereby cooled to about 90°C by the flow of air from blower 22. Such dilution allows more uniform distribution of heat throughout the space to be heated. Dilution also provides a safety feature by lowering the temperature from a dangerously high level to a sufficiently cool level at which ignition of adjacent materials cannot occur.

[0048] Second, the induced flow of exhaust gases out of combustion chamber 26 reduces the pressure within chamber 26, thereby allowing an increased flow of primary air into element 23 via air duct 24. The increased air flow enables the space heater of the present embodiment to maintain a uniform combustion temperature in the range of 600° - 900°C with a smaller combustion surface area and burner. Such temperature control enables reduction of emissions as described above in connection with the first embodiment.

[0049] A third benefit of this embodiment of the invention is that environmental air propelled by blower 22 through passage 30 between wall 33 and housing 21 serves to prevent the housing from becoming excessively hot during operation of the heater and preheats the air. This reduction of the housing temperature enables the safe use of lower cost housing materials that are aesthetically more pleasing.

[0050] It is important to note that the environmental air circulated through passage 30 by blower 22 does not participate in combustion of the fuel. Further, blower 22 contacts no gases produced by the combustion. Thus, in this embodiment of the present invention, blower 22 is required to act on neither air supplied to nor products from combustion. The sole purpose of blower 22 is to supply a volume of environmental air at a velocity sufficient to entrain gases produced in the combustion chamber and to propel the heated air and combustion products into the space being heated. The environmental air is thereby mixed with those gases, diluting the heat of combustion to a safely useable level.

[0051] The subatmospheric pressure achieved in this embodiment resulted in an increase in the combustion loading to 644 MJoules/m^2 hr compared to a combustion loading of 540 MJoules/m^2 hr in an equivalent conventional low NO_x room heater. This is an increase of about 20% in the combustion loading which corresponds with a 20% decrease in the combustion surface area for a given heat input rating.

[0052] The burner of this embodiment provides primarily convective heat transfer. This burner, when mounted in an overhead heater, was measured to provide radiant heat transfer in the range of 19 to 25% of the total heat released by combustion.

[0053] According to both illustrated embodiments of the present invention, natural or aspirated drafts may be used to maintain a subatmospheric pressure in a combustion chamber which enables the size of the combustion surface area and burner to be reduced for a given heat energy input or burner rating. Also, the emissions of CO and NO_x can be substantially reduced in such draft assisted burners by using preferred combinations of burner operating conditions.

[0054] A further advantage of the use of the presently disclosed burners in combination with the natural or aspirated draft effects is the reduction in size of the air/fuel mixing device, which is preferably embodied by an air duct, but which may also be a venturi. For example, in a standard water heater a burner having comparable combustion element rating or combustion loading, but without the benefit of natural or aspirated drafts, would require a venturi approximately 10 inches (254 mm) in length to provide sufficient mixing of fuel and air to sustain smooth, even combustion. In the present invention, the air duct preferably used has a length of only about 4.5 inches (114.3 mm), a reduction of over fifty percent in length of the air/fuel delivery device from the non-draft burner having a comparable burner rating. Such a reduction is possible because the draft acts to increase flow of air and fuel through the combustion surface for smooth, even combustion thereof.

[0055] Finally, there is opportunity for further savings in operating costs due to potential increases in the heating efficiency of these heaters and other similar devices.

[0056] The following example is provided as illustration, and is not intended to limit the scope of the present invention in any manner.

EXAMPLE

[0057] The following example demonstrates the results obtainable with the present invention in the first embodiment of the invention, a water heater application. In this example the combustion surface is made of inconel 601 wire screen, and has a diameter of 168 mm (6.6 inches) and thickness of 0.36 mm (0.014 inches). The air/fuel mixture contained approximately 20% excess air, above the stoichiometric amount. The combustion element was installed in a 182 litre (40 gallon) residential water heater. Three modifications were made to the water heater: (1) the combustion zone, bound by the bottom pan, inner skirt and inner door, was sealed to reduce secondary air, (2) a mat of insulation was placed on the floor shield to eliminate resonance noise and reduce heat loss, and (3) the flue stack baffle was replaced with a baffle designed to provide efficient heat transfer without excessive air flow reduction. In the following chart, tests 1 and 2 display results obtained with two levels of natural gas input. Test 3 is a duplicate of test 2, used to compare consistency of results.

TABLE

Test No.	MJ/hr Input	ppm CO	ppm NO_x	ppm NO	ppm NO_2	% Rec. Eff.
1	36.682 (34,770 BTU/hr)	45	9.0	7.1	1.85	68
2	33.232 (31,500 BTU/hr)	54	9.0	6.64	2.36	73
3	33.232 (31,500 BTU/hr)	54	9.0	6.64	2.36	73

[0058] Although preferred embodiments of this invention have been shown and described, it should be understood that various modifications and rearrangements of the parts may be resorted to without departing from the scope of the invention as disclosed and claimed herein.

Claims

1. A gas-fired burner apparatus (1) for providing substantially convective heat transfer, said burner (2, 23) including:

air/fuel supply means (7, 7a; 24, 24a) for receiving a flow of gaseous fuel from a source thereof and operating to aspirate and combine a primary combustion air component therewith to form a combustible air/fuel mixture for delivery to a plenum chamber at a plenum pressure, said air component being greater than that required for theoretically complete combustion;
said plenum chamber (4, 27) including a porous combustion surface (5, 25);
a combustion chamber (8, 26) containing said combustion surface (5, 25), said combustion chamber being substantially sealed to prevent the entrance of secondary air and including a discharge opening (9, 31) for products of combustion received from said burner, said discharge opening being an open lower end of a flued stack (9) which extends upwardly and which is open at its upper end to the environment whereby said discharge opening is in fluid communication with the environment and being arranged to produce a subatmospheric pressure in said combustion chamber in response to the flow of the products of combustion into the environment, said subatmospheric pressure cooperating with said plenum pressure to cause said air/fuel mixture to flow through said combustion surface (5, 25) at a rate which exceeds the flow rate that would exist if the combustion chamber was at atmospheric pressure whereby the area of the combustion surface is reduced for a given heat energy input and burner rating as compared with the area of the combustion surface required for the same heat energy input and burner rating if the combustion chamber was at atmospheric pressure.

2. A burner apparatus according to claim 1, wherein said burner has a combustion temperature in the range of from about 600°C to about 900°C.

3. A burner apparatus according to claim 1 or claim 2, wherein the burner loading is 20% to 400% in excess of the loading that would be produced in the absence of said subatmospheric pressure.

4. A burner apparatus according to any one of the preceding claims, wherein said burner has a combustion loading in the range of from about 500 to 2000 MJoules/m^2hr.

5. A burner apparatus according to any one of the preceding claims, wherein said air component is from about 110% to about 200% of that required for theoretically complete combustion.

6. A burner apparatus according to any one of the preceding claims, wherein said air/fuel supply means comprises a duct (7) having an inlet end for receiving said flow of fuel and aspirating said primary combustion air component from environmental air, and an outlet end for discharging said combustible air/fuel mixture in said plenum chamber.

7. A burner apparatus according to claim 6, wherein said duct (7) is a venturi.

8. A burner apparatus according to any one of the preceding claims, wherein said combustion surface (5) extends in a substantially horizontal orientation to enhance the uniformity of combustion.

9. A burner apparatus according to any one of the preceding claims, wherein said combustion chamber discharge opening is connected to an atmospheric vent (9) for discharging said products of combustion to the atmosphere solely due to their natural buoyancy.

10. A water heater (3) including a tank (10) defining a water chamber and having a burner apparatus (1) in accordance with any one of claims 1 to 9 mounted below said water chamber.

11. A water heater (3) according to claim 10, including a dome-shaped upwardly concave wall (11) providing a lower end surface of said water chamber (10) and an upper surface of said burner combustion chamber (8).

12. A water heater according to claim 11, wherein the products of combustion flow in a substantially uninterrupted manner upwardly along said concave wall (11) to said discharge opening and through said vent (9) to establish said subatmospheric pressure in said combustion chamber without requiring powered mechanical flow producing devices.

13. A burner apparatus according to any one of claims 1 to 8, wherein said combustion chamber discharge opening is connected with a room heater outlet (29) for flowing circulating air together with the products of combustion either indirectly into an exhaust flue or directly into a space to be temperature conditioned.

14. A burner apparatus according to claim 13, wherein said circulating air flows past said combustion chamber discharge opening and aspirates products of combustion from said combustion chamber (26) into the flow of circulating air.

15. A room heater (20) including a housing containing a burner apparatus in accordance with claim 14, a bypass air passage (30) separated from said combustion chamber by a wall (33), a powered blower (22) producing a substantial bypass flow of said circulating air from an environmental air inlet through said bypass air passage to a bypass discharge nozzle (32) operating to provide a jet of circulating air flowing past said combustion chamber discharge opening (31) to said room heater outlet (29), said jet of circulating air entraining by aspiration sufficient products of combustion from said combustion chamber to produce said subatmospheric pressure in said combustion chamber (26).

16. A room heater according to claim 15, wherein said bypass wall (33) provides a heat exchange surface between said combustion chamber (26) and bypass air passage causing preliminary heating of said bypass air before it reaches said discharge nozzle.

17. A water heater (3) including a gas-fired burner apparatus in accordance with claim 1, said water heater comprising a tank (10) defining a vertically extending generally cylindrical water chamber, a dome shaped upwardly concave wall (11) forming the lower end of said water chamber and the upper surface of the combustion chamber (8), said flued stack (9) extending vertically along the centre of said water chamber and being open at its lower end to said combustion chamber through the central portion of said concave wall and at its upper end to the environment above said water chamber, the plenum chamber being disposed below said combustion surface, the air/fuel supply means comprising an air duct (7) open to said plenum chamber, and a supply of gaseous fuel (7a) connected to said air duct operating to combine with an amount of primary air into said plenum chamber sufficient to establish a greater than stoichiometric mixture, said combustion chamber being substantially sealed except for said air duct and the lower end of said flue stack so that secondary combustion air does not enter said combustion chamber, the combustion gases resulting from combustion of said gaseous fuel and primary air flowing in a substantially uninterrupted manner upwardly along said concave surface (11) to said flue stack (9) and through said flue stack to establish a subatmospheric pressure in said combustion chamber without requiring powered mechanical flow producing devices.

18. A water heater (3) according to claim 17, wherein said dome-shaped upwardly concave wall (11) operates to funnel said combustion gases in said to flue stack (9), said concave wall providing substantially convective heat exchange between said combustion gases and said water chamber.

19. A water heater (3) according to claim 17 or claim 18, wherein said combustion chamber (8) has a lower wall, and a layer of insulation is positioned along said lower wall to reduce noise during combustion and to reduce heat losses through said lower wall.

20. A water heater (3) according to any one of claims 17 to 19, wherein said air duct (7) operates to deliver to said plenum chamber at least about 120% of the amount of air required to cause complete combustion of said fuel.

21. A water heater (3) as set forth in any one of claims 17 to 20, wherein said combustion occurs at a temperature between 600°C and 900°C.

22. A water heater (3) as set forth in any one of claims 17 to 21, wherein said air duct is a venturi (7).

23. A room heater comprising a burner having a porous combustion surface (25), a combustion chamber (26) above said combustion surface, which combustion chamber (26) is substantially sealed to prevent the entrance of secondary air a fuel air plenum (27) below said combustion surface, a source of gaseous fuel (24a), air duct means (24) for delivering said fuel to said plenum and operating in response to flow of said fuel to produce in said plenum an air/fuel mixture containing an amount of air in excess of the amount required to cause complete combustion of said fuel, a bypass air passage (30) separated from said combustion chamber (26) by a wall (33), a powered blower (22) for producing substantial bypass air flow from an environmental air inlet through said bypass passage to a bypass discharge nozzle (32) and operating to provide a jet of air directed to a heater discharge (29), said wall (33) providing a heat exchange surface between said combustion chamber and said bypass air passage causing preliminary heating of said bypass air before it reaches said nozzle (32), said combustion chamber (26) providing an exhaust (31) open to said jet of bypass air, the passage (30) and discharge nozzle (32) being arranged so that, in use, as environmental air from the blower (22) passes through the passage (30), it is forced through the discharge nozzle (32), which produces a downwardly directed jet of air of increased velocity which passes the discharge opening (31) of the combustion chamber (26) so entraining combustion products by aspiration and producing subatmospheric pressure in chamber (26), said jet of bypass air also mixing sufficient bypass air with the combustion gases to cause a safe temperature of the resulting mixture flowing through said heater discharge (29), said subatmospheric pressure in said combustion chamber (26) resulting in an increase in the pressure drop across said combustion surface (25) causing said air/fuel mixture passing through said burner to be greater than would be provided if said combustion chamber were at or above atmospheric pressure, whereby the area of the combustion surface is reduced for a given heat energy input and burner rating as compared with the area of the combustion surface required for the same heat energy input and burner rating if the combustion chamber was at atmospheric pressure.

24. A room heater (20) as set forth in claim 23, wherein said heater discharge (29) is at a level lower than said burner (23).

25. A room heater (20) as set forth in claim 24, wherein said wall (33) extends around said combustion chamber to said combustion chamber exhaust.

26. A method for operating a gas-fired burner apparatus (1), (23) for providing substantially convective heat transfer, comprising the steps of: using a fuel supply means (7a), (24a) to supply a flow of gaseous fuel, aspirating and combining primary combustion air in an air duct means (7), (24) in response to said flow of fuel to form a combustible air/fuel mixture for delivery to a plenum chamber (4, 27) at a plenum pressure, said air component being greater than that required for theoretically complete combustion, passing said air/fuel mixture through a porous combustion surface (5), (25) of said plenum chamber and into a combustion chamber (8), (26) which is substantially sealed to prevent entry of secondary air therein, combusting said air/fuel mixture at or near said combustion surface in said combustion chamber and removing the products of combustion from said combustion chamber to produce a sub-atmospheric pressure in said combustion chamber, flowing said air/fuel mixture under the influence of said sub-atmospheric pressure and plenum pressure through said combustion surface at a rate which exceeds the flow rate that would exist if the combustion chamber was at atmospheric pressure for a given heat energy input and burner rating, whereby the area of the combustion surface is reduced for a given heat energy input and burner rating as compared with the area of the combustion surface required for the same heat energy input and burner rating if the combustion chamber was at atmospheric pressure.

27. A method according to claim 26, including operating said burner at a combustion temperature in the range of from about 600°C to about 900°C.

28. A method according to claim 26 or claim 27 including operating the burner at a combustion loading of 20% to 400% in excess of the loading that would be produced in the absence of said subatmospheric pressure.

29. A method according to claim 28 including operating the burner at a combustion loading in the range of from about 500 to 2000 MJoules/m^2hr.

30. A method according to any one of claims 26 to 29 wherein the air component is in the range of from about 110% to about 200% of that required for theoretically complete combustion.

31. A method according to any one of claims 26 to 30, including the step of removing said products of combustion from said combustion chamber through an atmospheric vent (9) solely due to their natural buoyancy.

32. A method according to any one of claims 26 to 30, including the step of removing said products of combustion from said combustion chamber by aspirating and entraining said products of combustion in a flow of circulating air.

Patentansprüche

1. Mit Gas befeuerte Brenner-Vorrichtung (1) zum Erzeugen einer im wesentlichen konvektiven Wärmeübertragung, wobei der Brenner (2; 23) umfaßt:

- Luft/Brennstoff-Versorgungseinrichtungen (7, 7a; 24, 24a) zum Empfangen eines Stroms gasförmigen Brennstoffs von einer Quelle desselben und zum Ansaugen einer Primärverbrennungsluft-Komponente und Kombinieren derselben mit ihm zur Bildung eines brennbaren Luft-Brennstoff-Gemischs zur Abgabe an eine Plenumkammer bei einem Plenumdruck, wobei die genannte Luftkomponente größer als die für eine theoretisch vollständige Verbrennung erforderliche ist,
- die Plenumkammer (4; 27) umfaßt eine poröse Brennfläche (5; 25),
- eine die Brennfläche (5; 25) enthaltende Verbrennungskammer (8; 26), die im wesentlichen abgedichtet ist, um die Einleitung von Zusatzluft zu verhindern, und eine Abgabeöffnung (9; 31) für vom Brenner empfangene Verbrennungsprodukte aufweist, wobei die Abgabeöffnung ein offenes unteres Ende eines Rauchzugkamins (9) ist, der sich senkrecht erstreckt und an seinem oberen Ende in die Umgebung mündet, wodurch die Abgabeöffnung mit der Umgebung in Fluidverbindung steht und so ausgelegt ist, daß in der Verbrennungskammer in Abhängigkeit vom Verbrennungsproduktestrom in die Umgebung ein Unterdruck entsteht, der mit dem Plenumdruck zusammenwirkt, um zu bewirken, daß das genannte Luft-Brennstoff-Gemisch die Brennfläche (5; 25) mit einer Rate durchströmt, die größer als die Strömungsrate ist, welche bei unter atmosphärischem Druck stehender Verbrennungskammer bestehen würde, wodurch der Flächeninhalt der Brennfläche bei gegebener Wärmeenergieeingabe und Brennerleistung im Vergleich zum Flächeninhalt der Brennfläche verkleinert ist, der bei gleicher Wärmeenergieeingabe und Brennerleistung erforderlich wäre, wenn die Verbrennungskammer unter atmosphärischem Druck stünde.

2. Brenner-Vorrichtung nach Anspruch 1,
bei der der Brenner eine Verbrennungstemperatur im Bereich von etwa 600 °C bis etwa 900 °C hat.

3. Brenner-Vorrichtung nach Anspruch 1 oder Anspruch 2, bei der die Brennleistung 20% bis 400% über der Leistung liegt, die bei Fehlen des genannten Unterdrucks erzeugt würde.

4. Brenner-Vorrichtung nach einem der vorhergehenden Ansprüche, bei der der Brenner eine Brennleistung im Bereich von etwa 500 bis 2000 MJoule/m^2h hat.

5. Brenner-Vorrichtung nach einem der vorhergehenden Ansprüche, bei der die Luftkomponente zwischen etwa 110% und etwa 200% der für eine theoretisch vollständige Verbrennung erforderlichen beträgt.

6. Brenner-Vorrichtung nach einem der vorhergehenden Ansprüche, bei der die Luft-Brennstoff-Versorgungseinrichtungen eine Leitung (7) umfassen, die ein Einlaßende zum Empfangen des genannten Brennstoffstromes und zum Ansaugen der Primärverbrennungsluft-Komponente aus der Umgebungsluft aufweist, und ein Auslaßende zur Abgabe des brennbaren Luft-Brennstoff-Gemischs in die Plenumkammer.

7. Brenner-Vorrichtung nach Anspruch 6, bei der die Leitung (7) ein Venturirohr ist.

8. Brenner-Vorrichtung nach einem der vorhergehenden Ansprüche, bei der die Brennfläche (5) im wesentlichen waagerecht ausgerichtet ist, um die Gleichmäßigkeit der Verbrennung zu fördern.

9. Brenner-Vorrichtung nach einem der vorhergehenden Ansprüche, bei der die Abgabeöffnung der Verbrennungskammer mit einer atmosphärischen Entlüftungsöffnung (9) zur Abgabe der genannten Verbrennungsprodukte an die Atmosphäre allein als Folge deren natürlichen Auftriebs verbunden ist.

10. Warmwasserbereiter (3) mit einem eine Wasserkammer bildenden Behälter (10) und einer unter der Wasserkammer angeordneten Brenner-Vorrichtung (1) gemäß einem der Ansprüche 1 bis 9.

11. Warmwasserbereiter (3) nach Anspruch 10, mit einer kuppelförmigen, nach oben konkaven Wand (11), die eine untere Endfläche der Wasserkammer (10) und eine obere Fläche der Brenner-Verbrennungskammer (8) bildet.

12. Warmwasserbereiter nach Anspruch 11, bei dem die Verbrennungsprodukte im wesentlichen ununterbrochen nach oben entlang der konkaven Wand (11) zur Abgabeöffnung und durch die Entlüftungsöffnung (9) strömen, um in der Verbrennungskammer den genannten Unterdruck zu erzeugen, ohne daß kraftgetriebene mechanische Strömungserzeuger erforderlich sind.

13. Brenner-Vorrichtung nach einem der Ansprüche 1 bis 8, bei der die Abgabeöffnung der Verbrennungskammer mit einem Raumheizofen-Auslaß (29) verbunden ist, der Zirkulationsluft zusammen mit den Verbrennungsprodukten entweder indirekt in einen Abgaszug oder direkt in einen Raum strömen läßt, dessen Temperatur geregelt werden soll.

14. Brenner-Vorrichtung nach Anspruch 13, bei der die Zirkulationsluft an der Abgabeöffnung der Verbrennungskammer vorbeiströmt und Verbrennungsprodukte aus der Verbrennungskammer (26) in den Zirkulationsluftstrom ansaugt.

15. Raumheizofen (20) mit einem eine Brenner-Vorrichtung nach Anspruch 14 enthaltenden Gehäuse, einem Nebenluftkanal (30), der durch eine Wand (33) von der Verbrennungskammer getrennt ist, einem kraftgetriebenen Gebläse (22), das einen beträchtlichen Nebenstrom der Zirkulationsluft von einem Umgebungslufteinlaß durch den genannten Nebenluftkanal zu einer Nebenabgabedüse (32) erzeugt, die einen Zirkulationstuftstrahl an der Abgabeöffnung (31) der Verbrennungskammer vorbei zum Raumheizofenauslaß (29) erzeugt, wobei der Zirkulationsluftstrahl durch Ansaugung ausreichende Verbrennungsprodukte aus der Verbrennungskammer mitreißt, um in der Verbrennungskammer (26) den genannten Unterdruck zu erzeugen.

16. Raumheizofen nach Anspruch 15, bei dem die Nebenleitungswand (33) eine Wärmeaustauschfläche zwischen der Verbrennungskammer (26) und dem Nebenluftkanal bildet, welche die Nebenluft vorerwärmt, bevor sie die genannte Abgabedüse erreicht.

17. Warmwasserbereiter (3) mit einer gasbefeuerten Brenner-Vorrichtung nach Anspruch 1, umfassend: einen Behälter (10), der eine sich senkrecht erstreckende, im wesentlichen zylindrische Wasserkammer bildet, eine kuppelförmige, nach oben konkave Wand (11), die das untere Ende der Wasserkammer und die Oberseite der Verbrennungskammer (8) bildet, wobei der Rauchzugkamin (9) sich entlang der Mitte der Wasserkammer senkrecht erstreckt und an seinem unteren Ende durch den Mittelabschnitt der konkaven Wand in die Verbrennungskammer mündet und an seinem oberen Ende zur Umgebung über der genannten Wasserkammer hin offen ist, die Plenumkammer unter der Brennfläche angeordnet ist, die Luft-Brennstoff-Versorgungseinrichtungen eine in die Plenumkammer mündende Luftleitung (7) und eine mit der Luftleitung verbundene Quelle (7a) für gasförmigen Brennstoff aufweisen, die in die Plenumkammer zur Vereinigung eine Menge Primärluft einleitet, die ausreicht, um ein größeres als stöchiometrisches Gemisch herzustellen, die Verbrennungskammer, außer bei der Luftleitung und dem unteren Ende des Rauchzugkanals, im wesentlichen abgedichtet ist, so daß Zusatzverbrennungsluft nicht in die Verbrennungskammer einströmt, die Verbrennungsgase aus der Verbrennung des gasförmigen Brennstoffs und der Primärluft im wesentlichen ununterbrochen entlang der konkaven Fläche (11) nach oben zum Rauchzugkamin (9) und durch den Rauchzugkamin strömen, um in der Verbrennungskammer einen Unterdruck zu erzeugen, ohne daß kraftgetriebene mechanische Strömungserzeuger erforderlich sind.

18. Warmwasserbereiter (3) nach Anspruch 17, bei dem die kuppelförmige, nach oben konkave Wand (11) die Verbrennungsgase im Rauchzugkamin (9) zusammenführt, wobei die konkave Wand einen im wesentlichen konvektiven Wärmeübergang zwischen den Verbrennungsgasen und der Wasserkammer erzeugt.

19. Warmwasserbereiter (3) nach Anspruch 17 oder Anspruch 18, bei dem die Verbrennungskammer (8) eine untere Wand aufweist und an dieser unteren Wand eine Isolierschicht angeordnet ist, um Geräusche während der Verbrennung und Wärmeverluste durch diese untere Wand zu verringern.

20. Warmwasserbereiter (3) nach einem der Ansprüche 17 bis 19, bei dem die Luftleitung (7) der Plenumkammer wenigstens etwa 120% der zur vollständigem Verbrennung des Brennstoffs erforderlichen Luftmenge zuleitet.

21. Warmwasserbereiter (3) nach einem der Ansprüche 17 bis 20, bei dem die Verbrennung bei einer Temperatur zwischen 600 °C und 900 °C stattfindet.

22. Warmwasserbereiter (3) nach einem der Ansprüche 17 bis 21, bei dem die Luftleitung ein Venturirohr (7) ist.

23. Raumheizofen, umfassend: einen Brenner mit einer porösen Brennfläche (25), eine Verbrennungskammer (26) über der Brennfläche, die im wesentlichen abgedichtet ist, um das Einströmen von Zusatzluft zu verhindern, ein Brennstoff-Luft-Plenum (27) unter der Brennfläche, eine Quelle (24a) für gasförmigen Brennstoff, eine Luftleitung (24) zum Zuleiten des Brennstoffs zum Plenum und, in Abhängigkeit vom Brennstoffstrom, zum Erzeugen im Plenum eines Luft-Brennstoff-Gemischs, das eine Luftmenge enthält, die größer als die zur vollständigen Verbrennung des Brennstoffs erforderlichen ist, einen Nebenluftkanal (30), der von der Verbrennungskammer (26) durch eine Wand (33) getrennt ist, ein kraftgetriebenes Gebläse (22) zum Erzeugen eines beträchtlichen Nebenluftstroms von einem Umgebungslufteinlaß durch den Nebenkanal zu einer Nebenabgabedüse (32) und zum Erzeugen eines in eine Heizofenabgabeöffnung (29) gerichteten Luftstrahls, wobei die Wand (33) eine Wärmeübergangsfläche zwischen der Verbrennungskammer und dem Nebenluftkanal bildet, die eine Vorerwärmung der Nebenluft bewirkt, bevor diese die Düse (32) erreicht, die Verbrennungskammer (26) einen Auslaß (31) hat, der zum Nebenluftstrahl hin offen ist, der Kanal (30) und die Abgabedüse (32) so ausgelegt sind, daß im Betrieb, wenn Umgebungsluft vom Gebläse (22) durch den Kanal (30) strömt, sie durch die Abgabedüse (32) gepreßt wird, wodurch ein nach unten gerichteter Luftstrahl von erhöhter Geschwindigkeit erzeugt wird, der an der Abgabeöffnung (31) der Verbrennungskammer (26) vorbeiströmt und so durch Ansaugen Verbrennungsprodukte mitreißt und in der Kammer (26) Unterdruck erzeugt, wobei dieser Nebenluftstrahl auch genügend Nebenluft mit den Verbrennungsgasen mischt, um für das sich ergebende, durch die Heizofenabgabeöffnung (29) strömende Gemisch eine sichere Temperatur zustande zu bringen, wobei der Unterdruck in der Verbrennungskammer (26) zu einer Vergrößerung des Druckabfalls an der Brennfläche (25) führt, der bewirkt, daß das durch den Brenner strömende Luft-Brennstoff-Gemisch größer ist, als wenn in der Verbrennungskammer atmosphärischer oder höherer Druck herrscht, wodurch der Flächeninhalt der Brennfläche bei einer gegebenen Wärmeenergieeingabe und Brennerleistung im Vergleich mit dem Flächeninhalt der Brennfläche, die bei gleicher Wärmeenergieeingabe und Brennerleistung bei unter atmosphärischem Druck stehender Verbrennungskammer erforderlich wäre, verkleinert ist.

24. Raumheizofen (20) nach Anspruch 23, bei dem die Heizofenabgabeöffnung (29) auf einer niedrigeren Höhe als der Brenner (23) angeordnet ist.

25. Raumheizofen (20) nach Anspruch 24, bei dem sich die Wand (33) um die Verbrennungskammer zum Verbrennungskammerauslaß hin erstreckt.

26. Verfahren zum Betreiben einer mit Gas befeuerten Brenner-Vorrichtung (1; 23) zur Erzeugung eines im wesentlichen konvektiven Wärmeübergangs, mit den Schritten: Verwenden einer Brennstoffversorgungseinrichtung (7a; 24a) zum Zuführen eines Stroms gasförmigen Brennstoffs, Ansaugen und Kombinieren von Primärverbrennungsluft in einer Luftleitung (7; 24) in Abhängigkeit vom Brennstoffstrom, um ein brennbares Luft-Brennstoff-Gemisch zur Abgabe an eine Plenumkammer (4; 27) bei einem Plenumdruck zu bilden, wobei die Luftkomponente größer als die zur theoretisch vollständigen Verbrennung erforderliche ist, Durchleiten des Luft-Brennstoff-Gemischs durch eine poröse Brennfläche (5; 25) der Plenumkammer und in eine Verbrennungskammer (8; 26), die im wesentlichen abgedichtet ist, um das Einströmen von Zusatzluft zu verhindern, Verbrennen des Luft-Brennstoff-Gemischs an oder in der Nähe der Brennfläche in der Verbrennungskammer, und Entfernen der Verbrennungsprodukte aus der Verbrennungskammer, um in der Verbrennungskammer einen Unterdruck zu erzeugen, Strömenlassen des Luft-Brennstoff-Gemischs unter dem Einfluß dieses Unterdrucks und des Plenumdrucks durch die Brennfläche mit einer Rate, die größer als die Strömungsrate ist, die bei unter atmosphärischem Druck stehender Verbrennungskammer bei einer gegebenen Wärmeenergieeingabe und Brennerleistung bestehen würde, wodurch der Flächeninhalt der Brennfläche bei einer gegebenen Wärmeenerglееingabe und Brennerleistung im Vergleich zum Flächeninhalt der Brennfläche, die bei der gleichen Wärmeenergieeingabe und Brennerleistung erforderlich wäre, wenn die Verbrennungskammer unter atmosphärischem Druck steht, verkleinert ist.

27. Verfahren nach Anspruch 26, einschließlich des Betriebs des Brenners mit einer Verbrennungstemperatur im Bereich von etwa 600 °C bis etwa 900 °C.

28. Verfahren nach Anspruch 26 oder Anspruch 27, einschließlich des Betriebs des Brenners bei einer Brennleistung von 20% bis 400% über der Leistung, die bei Fehlen des Unterdruckes erzeugt würde.

29. Verfahren nach Anspruch 28, einschließlich des Betriebs des Brenners bei einer Brennleistung im Bereich von etwa 500 bis 2000 MJoule/m^2h.

30. Verfahren nach einem der Ansprüche 26 bis 29, bei dem die Luftkomponente im Bereich von etwa 110% bis etwa 200% der für die theoretisch vollständige Verbrennung erforderlichen liegt.

31. Verfahren nach einem der Ansprüche 26 bis 30, einschließlich des Schrittes der Entfernung der Verbrennungsprodukte aus der Verbrennungskammer durch eine atmosphärische Entlüftungsöffnung (9) allein als Folge deren natürlichen Auftriebs.

32. Verfahren nach einem der Ansprüche 26 bis 30, einschließlich des Schrittes der Entfernung der Verbrennungsprodukte aus der Verbrennungskammer durch Ansaugen und Mitreißen der Verbrennungsprodukte in einem Zirkulationsluftstrom.

Revendications

1. Brûleur au gaz (1) pour fournir un transfert de chaleur essentiellement par convection, ledit brûleur (2, 23) incluant :

des moyens d'alimentation en air/combustible (7, 7a ; 24, 24a) pour recevoir un écoulement de combustible gazeux provenant d'une source de celui-ci et fonctionnant pour aspirer et combiner avec celui-ci, un constituant d'air de combustion primaire, pour former un mélange air/combustible susceptible de brûler pour la délivrance à une chambre de répartition, à une pression de répartition, ledit constituant d'air étant supérieur à celui requis pour une combustion théoriquement complète ;
ladite chambre de répartition (4, 27) incluant une surface de combustion poreuse (5, 25) ;
une chambre de combustion (8, 26) contenant ladite surface de combustion (5, 25), ladite chambre de combustion étant sensiblement hermétique pour empêcher l'entrée d'air secondaire et incluant une ouverture d'évacuation (9, 31) pour les produits de combustion reçus depuis ledit brûleur, ladite ouverture d'évacuation étant une extrémité inférieure ouverte d'un conduit de cheminée (9) qui s'étend vers le haut et qui est ouvert à son extrémité supérieure vers l'environnement, de sorte que ladite ouverture d'évacuation est en communication fluidique avec l'environnement et se trouve disposée pour produire une pression subatmosphérique dans ladite chambre de combustion, en fonction de l'écoulement des produits de combustion dans l'environnement, ladite pression subatmosphérique coopérant avec ladite pression de répartition pour forcer ledit mélange air/combustible à s'écouler à travers ladite surface de combustion (5, 25), à une vitesse qui dépasse la vitesse d'écoulement qui existerait si la chambre de combustion était à pression atmosphérique, de sorte que l'aire de la surface de combustion est réduite pour une entrée d'énergie thermique et un calibre de brûleur donnés, par comparaison avec l'aire de la surface de combustion nécessaire pour la même entrée d'énergie thermique et le même calibre de brûleur si la chambre de combustion était à pression atmosphérique.

2. Brûleur selon la revendication 1, dans lequel ledit brûleur a une température de combustion dans la gamme d'environ 600°C à environ 900°C.

3. Brûleur selon la revendication 1 ou la revendication 2, dans lequel la charge du brûleur est de 20% à 400% en excès de la charge qui serait produite en l'absence de ladite pression subatmosphérique.

4. Brûleur selon l'une quelconque des revendications précédentes, dans lequel ledit brûleur a une charge de combustion dans la gamme d'environ 500 à 2000 Mjoules/m^2hr.

5. Brûleur selon l'une quelconque des revendications précédentes, dans lequel ledit constituant d'air est d'environ 110% à environ 200% de celui nécessaire pour une combustion théoriquement complète.

6. Brûleur selon l'une quelconque des revendications précédentes, dans lequel lesdits moyens d'alimentation en air/

combustible comprennent une canalisation (7) ayant une extrémité d'entrée pour recevoir ledit écoulement de combustible et aspirer ledit constituant d'air de combustion primaire à partir de l'air de l'environnement, et une extrémité de sortie pour évacuer ledit mélange air/combustible susceptible de brûler, dans ladite chambre de répartition.

7. Brûleur selon la revendication 6, dans lequel ladite canalisation (7) est un venturi.

8. Brûleur selon l'une quelconque des revendications précédentes, dans lequel ladite surface de combustion (5) s'étend selon une orientation sensiblement horizontale pour renforcer l'uniformité de la combustion.

9. Brûleur selon l'une quelconque des revendications précédentes, dans lequel ladite ouverture d'évacuation de la chambre de combustion est reliée à un évent atmosphérique (9) pour évacuer lesdits produits de combustion vers l'atmosphère uniquement grâce à leur force ascensionnelle naturelle.

10. Chauffe-eau (3) incluant un réservoir (10) définissant une chambre à eau et ayant un brûleur (1) selon l'une quelconque des revendications 1 à 9, monté en dessous de ladite chambre à eau.

11. Chauffe-eau (3) selon la revendication 10, incluant une paroi concave (11) s'étendant vers le haut, en forme de dôme, fournissant une surface d'extrémité inférieure de ladite chambre à eau (10) et une surface supérieure de ladite chambre de combustion (8) du brûleur.

12. Chauffe-eau selon la revendication 11, dans lequel les produits de combustion s'écoulent d'une manière sensiblement ininterrompue vers le haut, le long de ladite paroi concave (11), vers ladite ouverture d'évacuation et à travers ledit évent (9), pour établir ladite pression subatmosphérique dans ladite chambre de combustion, sans qu'il soit nécessaire d'avoir des dispositifs à moteur produisant un écoulement mécanique.

13. Brûleur selon l'une quelconque des revendications 1 à 8, dans lequel ladite ouverture d'évacuation de la chambre de combustion est reliée à une ouverture (29) d'un radiateur pour faire s'écouler l'air circulant conjointement avec les produits de combustion, soit indirectement dans un conduit d'évacuation, soit directement dans un espace qui doit être mis à température.

14. Brûleur selon la revendication 13, dans lequel ledit air circulant s'écoule au delà de ladite ouverture d'évacuation de la chambre de combustion et aspire des produits de combustion depuis ladite chambre de combustion (26) dans l'écoulement d'air circulant.

15. Radiateur (20) incluant un carter contenant un brûleur selon la revendication 14, un passage d'air de dérivation (30) séparé de ladite chambre de combustion par une paroi (33), une soufflerie à moteur (22) produisant un écoulement de dérivation important dudit air circulant, depuis une entrée d'air de l'environnement, à travers ledit passage d'air de dérivation, vers une buse d'évacuation de dérivation (32) fonctionnant pour fournir un jet d'air circulant, s'écoulant au delà de ladite ouverture d'évacuation (31) de la chambre de combustion, vers ladite sortie (29) du radiateur, ledit jet d'air circulant entraînant par aspiration suffisamment de produits de combustion provenant de ladite chambre de combustion, pour produire ladite pression subatmosphérique dans ladite chambre de combustion (26).

16. Radiateur selon la revendication 15, dans lequel ladite paroi de dérivation (33) fournit une surface d'échange de chaleur entre ladite chambre de combustion (26) et le passage d'air de dérivation, ce qui provoque un chauffage préliminaire dudit air de dérivation avant qu'il n'atteigne ladite buse d'évacuation.

17. Chauffe-eau (3) incluant un brûleur au gaz selon la revendication 1, ledit chauffe-eau comprenant un réservoir (10) définissant une chambre à eau généralement cylindrique, s'étendant verticalement, une paroi concave (11) s'étendant vers le haut, en forme de dôme, formant l'extrémité inférieure de ladite chambre à eau et la surface supérieure de ladite chambre de combustion (8), ledit conduit de cheminée (9) s'étendant verticalement le long du centre de ladite chambre à eau et étant ouvert à son extrémité inférieure vers ladite chambre de combustion à travers la portion centrale de ladite paroi concave et à son extrémité supérieure vers l'environnement, au dessus de ladite chambre à eau, la chambre de répartition étant disposée sous ladite surface de combustion, les moyens d'alimentation en air/combustible comprenant une canalisation d'air (7) ouverte vers ladite chambre de répartition, et une alimentation en combustible gazeux (7a), reliée à ladite canalisation d'air, fonctionnant pour combiner dans ladite chambre de répartition, une quantité d'air primaire suffisante pour établir un mélange plus que stoechiométrique, ladite chambre de combustion étant sensiblement hermétique sauf pour ladite canalisation d'air et l'extrémité inférieure dudit conduit de cheminée, de sorte que de l'air de combustion secondaire ne pénètre pas dans ladite chambre de combustion, les gaz de combustion résultant de la combustion dudit combustible gazeux et de l'air primaire s'écoulant d'une manière sensiblement ininterrompue vers le haut, le long de ladite surface concave (11), vers ledit conduit de cheminée (9) et à travers ledit conduit de cheminée, pour établir une pression subatmosphérique dans ladite chambre de combustion, sans qu'il soit nécessaire d'avoir des dispositifs à moteur produisant un écoulement mécanique.

18. Chauffe-eau (3) selon la revendication 17, dans lequel ladite paroi concave (11) s'étendant vers le haut, en forme de dôme, fonctionne pour canaliser lesdits gaz de combustion dans ledit conduit de cheminée (9), ladite paroi concave fournissant un échange de chaleur essentiellement par convection entre lesdits gaz de combustion et ladite chambre à eau.

19. Chauffe-eau (3) selon la revendication 17 ou la revendication 18, dans lequel ladite chambre de combustion (8) a une paroi inférieure, et une couche d'isolation est positionnée le long de ladite paroi inférieure pour réduire le bruit durant la combustion et pour réduire les pertes de chaleur à travers ladite paroi inférieure.

20. Chauffe-eau (3) selon l'une quelconque des revendications 17 à 19, dans lequel ladite canalisation d'air (7) fonctionne pour délivrer à ladite chambre de répartition au moins environ 120% de la quantité d'air nécessaire pour provoquer la combustion complète dudit combustible.

21. Chauffe-eau (3) tel qu'énoncé dans l'une quelconque des revendications 17 à 20, dans lequel ladite combustion survient à une température comprise entre 600°C et 900°C.

22. Chauffe-eau (3) tel qu'énoncé dans l'une quelconque des revendications 17 à 21, dans lequel ladite canalisation d'air est un venturi (7).

23. Radiateur comprenant un brûleur ayant une surface de combustion poreuse (25), une chambre de combustion (26) au dessus de ladite surface de combustion, ladite chambre de combustion (26) étant sensiblement hermétique pour empêcher l'entrée d'air secondaire, un répartiteur d'air et de combustible (27) sous ladite surface de combustion, une source de combustible gazeux (24a), des moyens de canalisation d'air (24) pour délivrer ledit combustible audit répartiteur et fonctionner en fonction de l'écoulement dudit combustible, pour produire dans ledit répartiteur, un mélange air/combustible contenant une quantité d'air en excès de la quantité nécessaire pour provoquer la combustion complète dudit combustible, un passage d'air de dérivation (30) séparé de ladite chambre de combustion (26) par une paroi (33), une soufflerie à moteur (22) pour produire un écoulement d'air de dérivation important depuis une entrée d'air de l'environnement, à travers ledit passage de dérivation, vers une buse d'évacuation de dérivation (32) et fonctionnant pour fournir un jet d'air dirigé vers une évacuation (29) du radiateur, ladite paroi (33) fournissant une surface d'échange de chaleur entre ladite chambre de combustion et ledit passage d'air de dérivation, ce qui provoque le chauffage préliminaire dudit air de dérivation, avant qu'il n'atteigne ladite buse (32), ladite chambre de combustion (26) fournissant un échappement (31) ouvert vers ledit jet d'air de dérivation, le passage (30) et la buse d'évacuation (32) étant disposés de façon que, lors de l'utilisation, lorsque de l'air de l'environnement provenant de la soufflerie (22) passe à travers le passage (30), il est forcé à travers la buse d'évacuation (32), ce qui produit un jet d'air dirigé vers le bas, de vitesse accrue qui passe par l'ouverture d'évacuation (31) de la chambre de combustion (26), en entraînant ainsi les produits de combustion par aspiration et en produisant une pression subatmosphérique dans la chambre (26), ledit jet d'air de dérivation mélangeant également suffisamment d'air de dérivation avec les gaz de combustion pour provoquer une température sûre du mélange obtenu s'écoulant à travers ladite évacuation (29) du radiateur, ladite pression subatmosphérique dans ladite chambre de combustion (26) aboutissant à une augmentation de la chute de pression à travers ladite surface de combustion (25), ce qui force ledit mélange air/combustible passant à travers ledit brûleur à être plus important qu'il ne le serait si ladite chambre de combustion était à la pression atmosphérique ou au dessus, de sorte que l'aire de la surface de combustion est réduite pour une entrée d'énergie thermique et un calibre de brûleur donnés, par comparaison avec l'aire de la surface de combustion nécessaire pour la même entrée d'énergie thermique et le même calibre de brûleur si la chambre de combustion était à pression atmosphérique.

24. Radiateur (20) tel qu'énoncé dans la revendication 23, dans lequel ladite évacuation (29) du radiateur est à un niveau inférieur à celui dudit brûleur (23).

25. Radiateur (20) tel qu'énoncé dans la revendication 24, dans lequel ladite paroi (33) s'étend autour de ladite chambre de combustion vers ledit échappement de la chambre de combustion.

26. Procédé de fonctionnement d'un brûleur au gaz (1), (23) pour fournir un transfert de chaleur essentiellement par convection, comprenant les étapes consistant à : utiliser des moyens d'alimentation en combustible (7a), (24a) pour introduire un écoulement de combustible gazeux, aspirer et combiner de l'air de combustion primaire dans un moyen de canalisation d'air (7), (24) en fonction dudit écoulement de combustible, pour former un mélange air/combustible susceptible de brûler pour la délivrance à une chambre de répartition (4, 27) à une pression de répartition, ledit constituant d'air étant supérieur à celui nécessaire pour une combustion théoriquement complète, faire passer ledit mélange air/combustible à travers une surface de combustion poreuse (5), (25) de ladite chambre de répartition et dans une chambre de combustion (8), (26) qui est sensiblement hermétique pour empêcher l'entrée d'air secondaire à l'intérieur de celle-ci, taire brûler ledit mélange air/combustible au niveau ou à proximité de ladite surface de combustion dans ladite chambre de combustion et éliminer les produits de combustion de ladite chambre de combustion, pour produire une pression subatmosphérique dans ladite chambre de combustion, faire s'écouler ledit mélange air/combustible sous l'influence de ladite pression subatmosphérique et de la pression de répartition, à travers ladite surface de combustion, a une vitesse qui dépasse la vitesse d'écoulement qui existerait si la chambre de combustion était à la pression atmosphérique pour une entrée d'énergie thermique et un calibre de brûleur donnés, de sorte que l'aire de la surface de combustion est réduite pour une entrée d'énergie thermique et un calibre de brûleur donnés, par comparaison avec l'aire de la surface de combustion nécessaire pour la même entrée d'énergie thermique et le même calibre de brûleur, si la chambre de combustion était à pression atmosphérique.

27. Procédé selon la revendication 26, incluant le fonctionnement dudit brûleur à une température de combustion dans la gamme d'environ 600°C à environ 900°C.

28. Procédé selon la revendication 26 ou la revendication 27, incluant le fonctionnement du brûleur à une charge de combustion de 20% à 400% en excès de la charge qui serait produite en l'absence de ladite pression subatmosphérique.

29. Procédé selon la revendication 28, incluant le fonctionnement du brûleur à une charge de combustion dans la gamme d'environ 50 à 2000 Mjoules/m^2hr.

30. Procédé selon l'une quelconque des revendications 26 à 29, dans lequel le constituant d'air est dans la gamine d'environ 110% à environ 200% de celui nécessaire pour une combustion théoriquement complète.

31. Procédé selon l'une quelconque des revendications 26 à 30, incluant l'étape d'élimination desdits produits de combustion de ladite chambre de combustion, à travers un évent atmosphérique (9) uniquement grâce à leur force ascensionnelle naturelle.

32. Procédé selon l'une quelconque des revendications 26 à 30, incluant l'étape d'élimination desdits produits de combustion de ladite chambre de combustion en aspirant et en entraînant lesdits produits de combustion dans un écoulement d'air circulant.

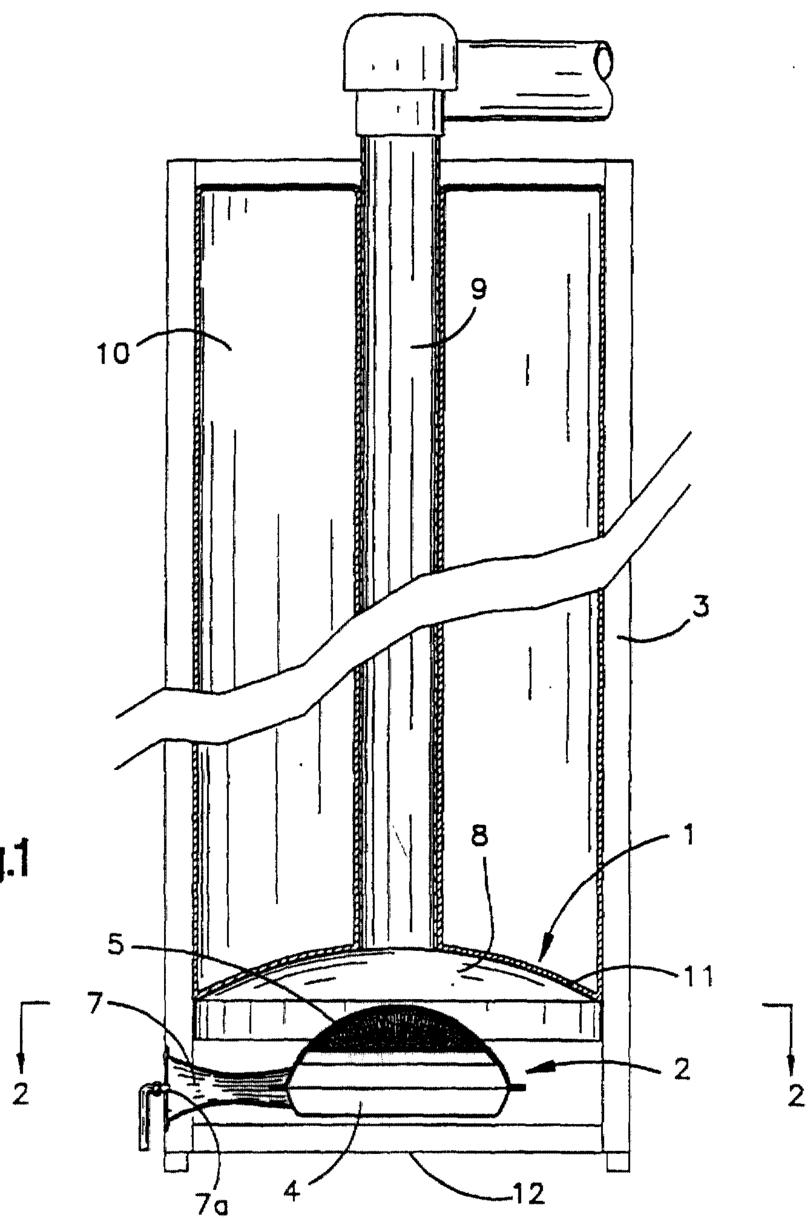

Fig.1

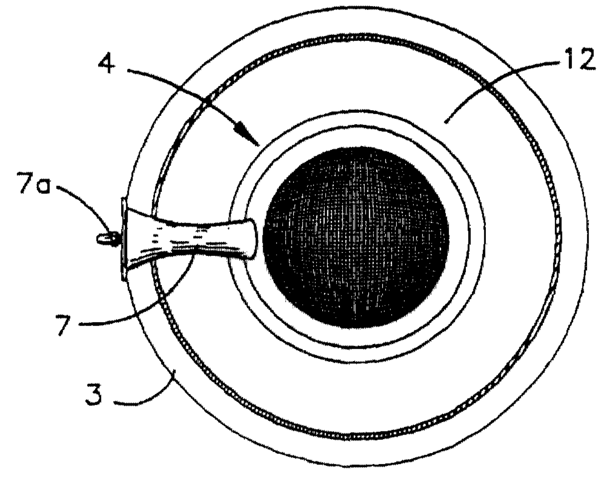

Fig.2

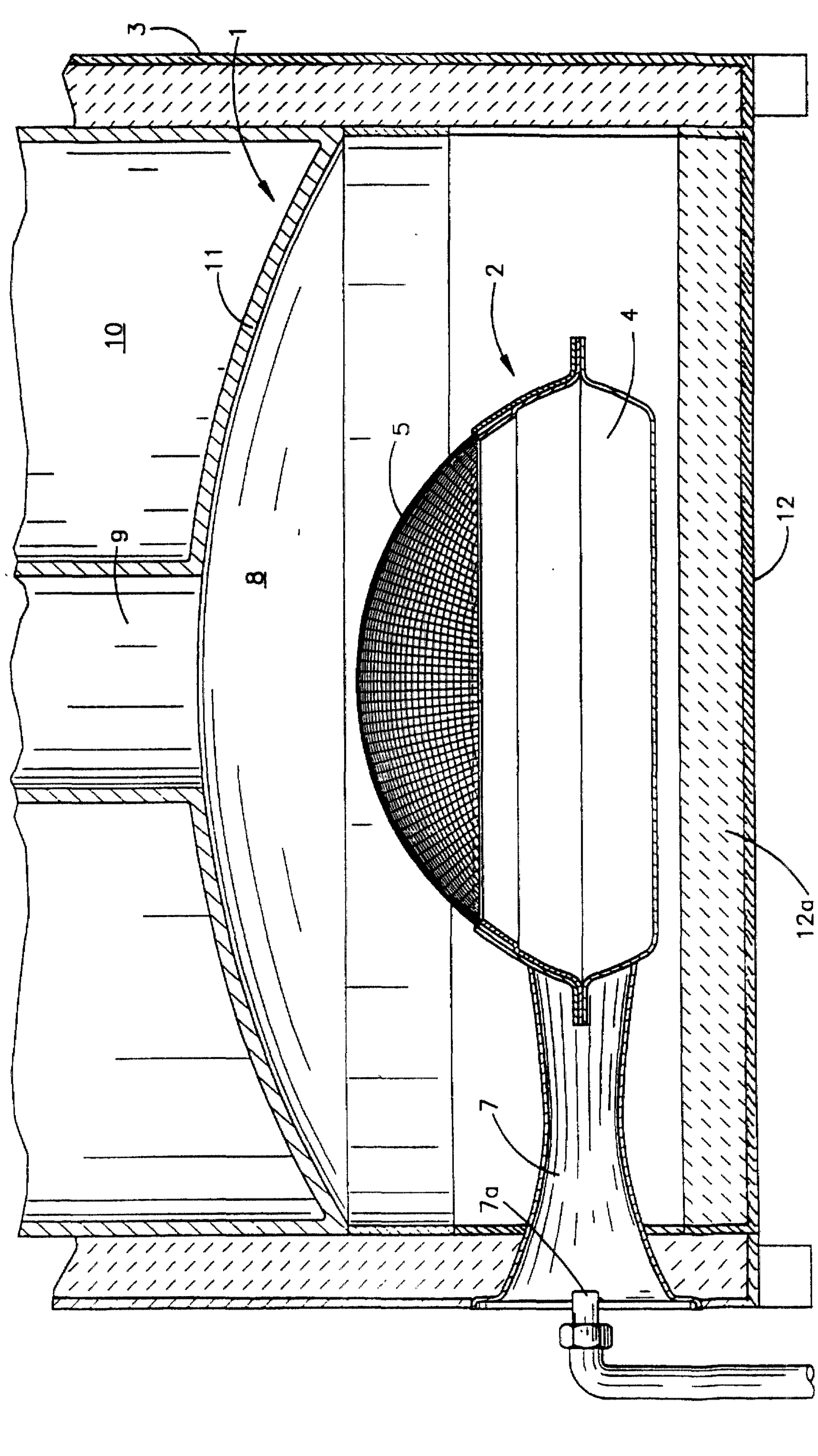

Fig.3

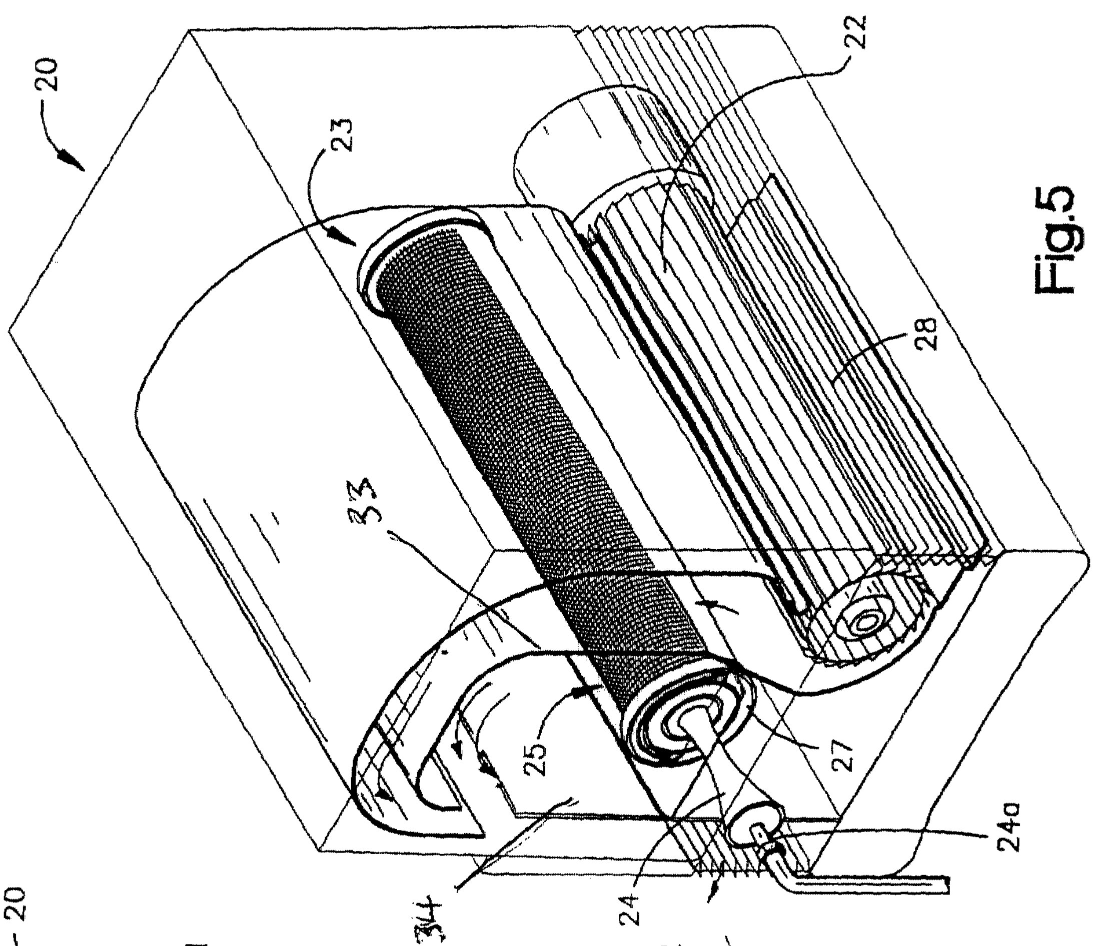

Fig.5

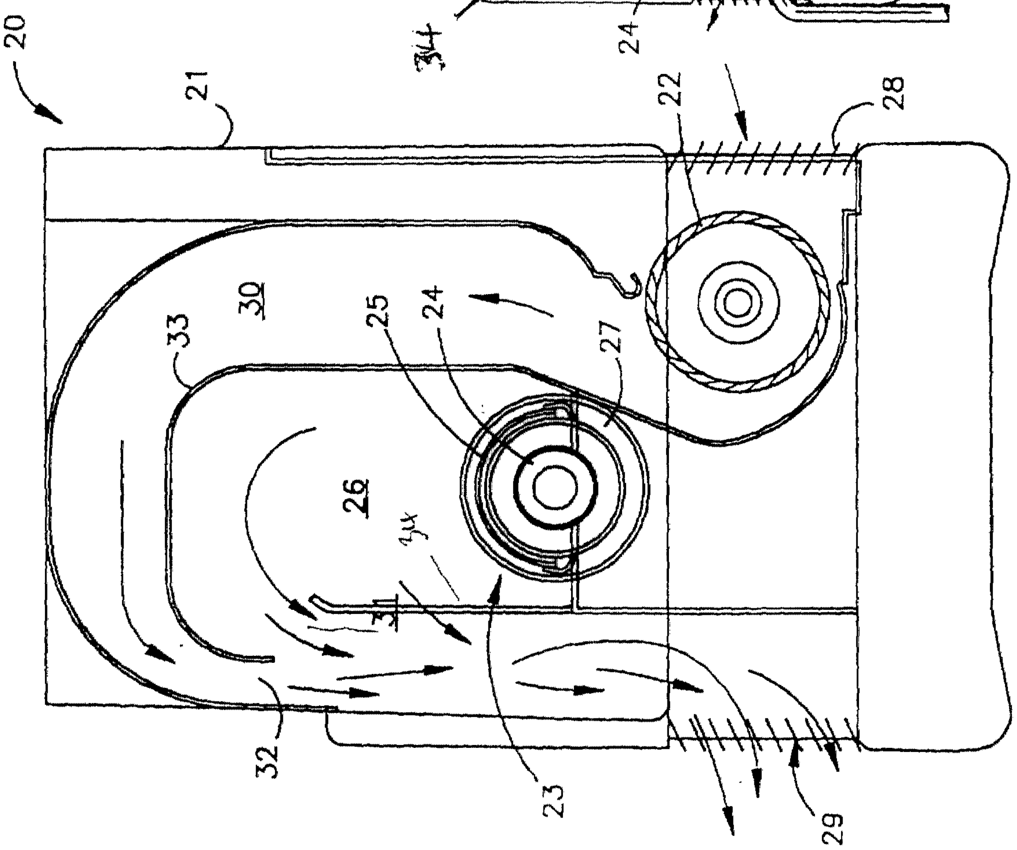

Fig.4