Sept. 30, 1969 F. HAAG 3,469,929

PULSE JET BURNER

Filed Dec. 20, 1967

FIG. 1

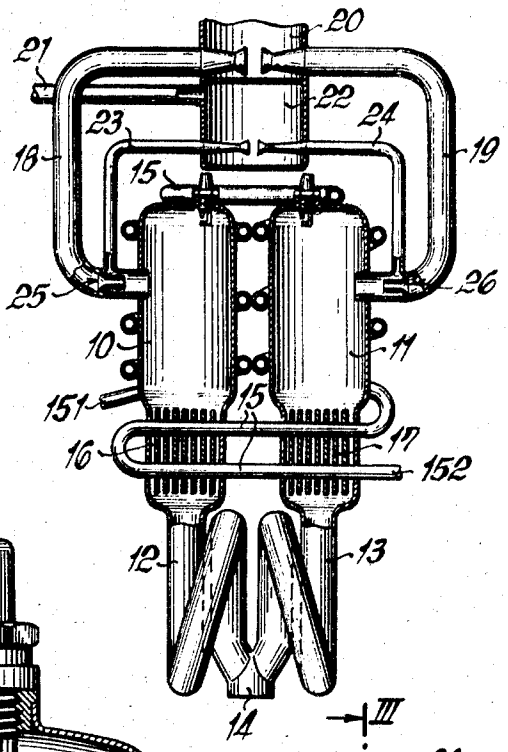


FIG. 2

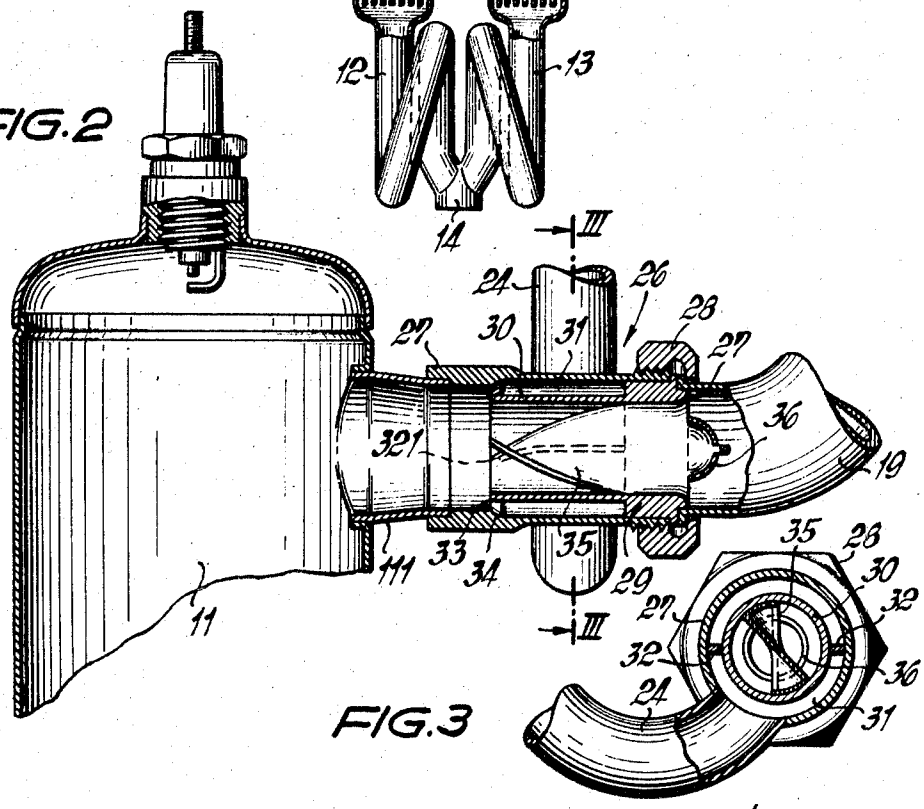


FIG. 3

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ABSTRACT OF THE DISCLOSURE

A pulse jet burner having a combustion chamber, a resonance duct communicating with one end of the combustion chamber, and mixing tube means for feeding a mixture of combustion air and fuel into the combustion chamber and constructed in such a manner so as to impart at least to the combustion air passing therethrough a rotary movement to enhance intimate mixing of air and fuel shortly before the same enter the combustion chamber.

BACKGROUND OF THE INVENTION

The present invention relates to a pulse jet burner having at least one combustion chamber and a resonance duct communicating with one end of the latter, in which a mixing tube for feeding a mixture of combustion air and fuel feeds this mixture laterally into the combustion chamber.

In order to provide a high output pulse jet burner with a relatively small combustion chamber, which will permit use of the pulse jet burner as a household implement, for instance as a heat source for a central heating plant of a home, it is necessary that the pulsating combustions will follow each other at short intervals. This means that there will be only a very short time available for filling the combustion chamber between the successive combustion periods with the necessary air-fuel mixture. Advantageously, feeding of air and fuel into the combustion chamber is not controlled by valves, and in this case it is necessary that air and fuel are mixed with each other only in close proximity to the combustion chamber, since otherwise, especially with easily ignitable fuels, the igniting and combustion zone moves into the conduit which feeds the mixture into the combustion chamber so that the combustion of the mixture will start in the aforementioned conduit. When this happens, the operating frequency of the pulse jet burner, to which the size and lengths of the combustion chamber and the following resonance tube are tuned, will be changed so that the pulsating combustion will get out of step, or at least the output of the burner will be reduced by the change in frequency and by uncomplete combustion of the mixture. These disadvantages occur especially in pulse jet burners in which a gas is used as fuel, since the various fuel gases which are used in industrial and domestic plants are differently ignitable so that combustion in the mentioned pulse jet burner would start at different localized zones resulting also in different operating frequencies.

It is an object of the present invention to eliminate the above disadvantages in pulse jet burners of the aforementioned kind.

It is a further object of the present invention to provide a pulse jet burner of the aforementioned kind in which an intimate mixture of combustion air and fuel is obtained over a short path to assure thereby a uniform combustion independent of the relative ignitability of the used fuel.

It is an additional object of the present invention to provide for a pulse jet burner of the aforementioned kind which is composed of relatively few and simple parts, so

that the burner may be manufactured at reasonable cost and stand up properly after extended use.

SUMMARY OF THE INVENTION

With these objects in view, the pulse jet burner according to the present invention mainly comprises at least one combustion chamber, mixing tube means for feeding a mixture of combustion air and fuel into the latter, the mixing tube means comprising outer tube means communicating at one end with the combustion chamber, a sleeve having a diameter smaller than the outer tube means and being coaxially arranged in the latter so as to define with the inner surface of the outer tube means and the outer surface of the sleeve an annular gap, the sleeve having one end axially spaced from the one end of the outer tube means, means for closing the annular gap at the other end of the sleeve, a first conduit communicating with the other end of the sleeve for feeding combustion air into the latter, a second conduit communicating with the annular gap for feeding fuel into the latter, and means in the sleeve for imparting to the combustion air passing therethrough a twisting movement to provide an increased mixing action combustion air and fuel in the space between the one end of the sleeve and the one end of the outer tube means; and a resonance duct communicating with the interior of the combustion chambers spaced from the one end of the outer tube means. The means for imparting a twisting movement to the combustion air are preferably constituted by a spirally wound sheet metal member in the sleeve.

Very stable operating conditions of the pulse jet burner according to the present invention are obtained, on the one hand, due to the mixing of combustion air and fuel only a short distance before the mixture enters into the combustion chamber, and, on the other hand, due to the intimate mixing of fuel and air obtained by the spirally wound sheet metal member in the sleeve which imparts to the incoming air a rotary movement so that the centrifugal forces imparted to the air will force the latter, as it leaves the sleeve, against the inner surface of the outer tube so as to be thoroughly mixed with the fuel which passes through the annular gap between the inner surface of the outer tube and the outer surface of the sleeve.

In a preferred form the spirally wound sheet metal member extends through the length of the sleeve and is twisted through an angle of at least 90 degrees.

It is also possible to provide means in the annular gap so that the fuel will be fed only through an angular portion of the annular gap. The annular gap may be divided for this purpose by two diametrically oppositely arranged webs into two separated, longitudinally extending compartments, only in one of which fuel is fed, and the two longitudinally extending webs may be bent at the one end of the sleeve in the same sense as the spirally wound sheet metal in the sleeve. An increased movement of the combustion air in radially outward direction may also be obtained by providing at the other end of the sleeve a calotte concentrically arranged therewith, and with the concave side of the calotte facing towards the interior of the sleeve. This calotte thus covers a central portion of the cross section of the sleeve so that the air is guided in an annular stream onto the spirally wound sheet metal member in the interior of the sleeve. It is also advantageous to form the cross section of the annular gap at the one end of the sleeve smaller than the remainder of the annular gap.

By dividing the annular gap by the webs into two longitudinally extending compartments and by bending the end portions of the annular webs and feeding fuel,

especially a fuel gas, only in one of the compartments, a rotary movement is imparted also to the fuel gas. This rotary movement will occur in the same sense as the rotary movement of the combustion air passing through the sleeve whereby any essential braking of the two streams during the mixture thereof is prevented, which would occur if the fuel stream would make a rotary movement opposite to that of the air stream. Nevertheless, an intimate mixture of the two streams is obtained, since the air and the fuel pass at different speeds to the region where they are mixed with each other. Due to the speed difference an optimum mixing of the two components is quickly obtained, which is even enhanced when gas is used as fuel since the lighter fuel gas will move in a spiral radially inwardly, whereas the heavier air will be driven radially outwardly due to the rotation thereof.

With a pulse jet burner according to the present invention it is possible to burn fuels with different ignition points completely and without causing any deviation from the proper operation of the burner. If fuel with a relatively low ignition point is used, the combustion process will be supported due to a relative circulation from the combustion chamber in direction toward the region where the mixture takes place, which will necessarily occur due to the rotary movement of the mixed components, so that a hot component mixture will pass from the combustion chamber into the mixing tube causing thereby combustion of the fuel. The feeding speed of air and fuel into the mixing tube may however be chosen in such a manner so that only a relative and not an absolute back flow from the combustion chamber into the mixing tube will occur so that in the region of the intermixing of the two components no undesired dilution of the forming mixture with burned gas will take place. An undesired dilution of the incoming mixture by burned gas is also prevented according to the present invention by the calotte which is arranged at the inlet end of the sleeve and facing with its concave side the interior of the latter, which calotte will thus provide in direction of the back flow a flow resistance which is three times greater than in the direction of inflow of the air. In addition, it is possible to provide the conduit which feeds air into the sleeve with a greater diameter than that of the sleeve which likewise results in an increase of the flow resistance of any back flow. A similar action is obtained by making the cross section of the annular gap between the sleeve and the outer tube of the mixing tube means at the downstream end of the sleeve smaller than the remainder of the annular gap.

An especially advantageous construction may be obtained when the outer tube means comprises in the region of the sleeve an intermediate tube portion releasably connected to the first conduit.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic overall view of a pulse jet burner according to the present invention;

FIG. 2 is an axial cross section through the mixing tube means and an adjacent portion of the combustion chamber; and

FIG. 3 is a cross section taken along the line III—III of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 schematically illustrates a pulse jet burner according to the present invention used as a heating source for a continuous water heater for production of hot water and/or for heating water for a central heating plant. The pulse jet burner shown in FIG. 1, comprises two combustion chambers **10** and **11**, resonance ducts **12** and **13** respectively communicating at one end thereof with one end of the respective combustion chamber and at the other end thereof with a common discharge opening **14**, and mixing tube means for feeding a mixture of combustion air and fuel into the combustion chambers intermediate the ends thereof. Sound absorbing chambers usually provided in pulse jet burners of this type are not illustrated in the drawing for simplification reason. The water to be heated by the burner according to the present invention is in a known manner guided through a conduit **15** which extends from its inlet end **151** connected to a cold water supply, not shown, in spiral form first about the exterior of the combustion chamber **10** in upward direction, then in another spiral about the exterior of the second combustion chamber **11** in a downward direction to pass finally through closely arranged heat exchange discs **17**, provided at downstream end portions of the combustion chambers, to the outlet end **152** of the tube **15** which is connected, in a manner not shown in the drawing, to a pipe which leads the heated water to a point of use.

Combustion air is fed to the two combustion chambers **10** and **11** from a space **20** through two air conduits **18** and **19**, whereas fuel is fed through a fuel conduit **21** into a chamber **22** from which two conduits **23** and **24** lead respectively to mixing tube means **25** and **26** where the fuel is intermixed with the air coming through the conduits **18** and **19**.

FIG. 2 illustrates the mixing tube means **26** for the combustion chamber **11** at an enlarged scale. The mixing tube means **26** illustrated in FIG. 2 comprises a connecting socket **111** communicating at one end thereof with the combustion chamber **11** and connected at the other end thereof to one end of an intermediate tube portion **27**, to the other end of which the air conduit **19** is connected by means of a screw cap **28**, screwed onto the threaded other end of the intermediate tube portion **27**. The screw cap **28** secures also an annular member **29** in the region of the other end of the intermediate tube portion **27** by clamping a radially outwardly extending flange of the annular member **29** between the other end of the intermediate tube portion **27** and a corresponding flange on the end of the air conduit **19**. The annular member **29** carries, integrally formed therewith a sleeve **30** projecting toward the combustion chamber **11** and having an outer diameter smaller than the inner diameter of the intermediate tube portion **27** so as to form with the latter an annular gap **31** between the outer surface of the sleeve **30** and the inner surface of the intermediate tube portion **27**. The annular gap **31** is divided by two diametrically oppositely arranged and longitudinally extending webs **32** into two halves or two compartments and the fuel conduit **24** communicates in substantially tangential direction only with one of these compartments, as best shown in FIG. 3. The two longitudinally extending webs **32** are in the region of the discharge opening **33** of the annular gap **31** bent as indicated at **321**, whereby a rotary movement is imparted to the fuel passing through the discharge end **33** of the annular gap. The annular gap **31** is at the end thereof distant from the combustion chamber **11** closed by the annular member **29** which carries the sleeve **30** and the annular member **29** forms, therefore, means for closing this end of the annular gap. As clearly shown in FIG. 2, the cross section of the discharge end **33** of the annular gap is smaller than the cross section of the remainder of the annular gap and reduction of the cross section of the annular gap at the discharge opening **33** is obtained by the frustoconical configuration **34** of the inner surface of the intermediate tube portion **27** in the region of the left end, as viewed

in FIG. 2, of the sleeve **30**. The inclination of the frustoconical surface portion **34** is at least 30 degrees.

Means are provided in the interior of the sleeve to impart to the combustion air passing there through a rotary movement, and these means are preferably formed by a spirally wound sheet metal member **35** which extends longitudinally through the whole length of the sleeve **30** and through the annular member **29** and which, in the illustrated embodiment, is spirally twisted through an angle of about 120 degrees. A calotte **36** is fastened concentrically with the annular member **29** to the right end, as viewed in FIG. 2, of the spirally wound sheet metal member **35**, with the concave side of the calotte **36** facing the interior of the sleeve. The calotte **36** has a diameter smaller than that of the inner diameter of the annular member **29** and covers the central portion of the latter. The inner diameter of the annular member **29** gradually decreases from the right or inlet end thereof over part of the length of the annular member from a miximum diameter substantially equal to the inner diameter of the conduit **19** to a minimum diameter substantially equal to the inner diameter of the sleeve **30** so that the flow resistance of the incoming air is reduced. A rotary movement is imparted to the air passing from the conduit **19** into the interior of the sleeve **30**, which sleeve is exchangeable arranged in the intermediate tube portion **27**, by the spirally wound sheet metal member **35** located in the sleeve, so that the air leaving the discharge end of the sleeve is guided in radially outward direction onto the inner surface of the left end portion, as viewed in FIG. 2, of the intermediate tube portion **27** and onto the inner surface of the connecting socket **111** bordering thereon. This guiding of the air in a rotary annular stream is initiated by the central calotte **36**. A rotary movement in the same sense, as imparted to the air stream, is also imparted to the fuel, which passes through one-half of the annular gap **31** and through the discharge opening **33** of this gap, by the bent end portions of the longitudinal webs **32** so that the fuel is guided in a stream having the shape of the half hollow cylinder into the fast rotating peripheral air stream to be thereby intimately mixed with the latter. A back flow of the mixture from the combustion chamber **11** into the intermediate tube portion **27**, created by the combustion of the mixture in the combustion chamber, is braked to a considerable extent by the concave surface of the callote **36**, the considerable increase of the flow cross section at the junction of the conduit **19** and the right end, as viewed in FIG. 2, of the annular member **29**, as well as by the increase of the diameter of the inner surface of the intermediate tube portion **27** at the frustoconical portion **34** thereof, so that an undesirable considerable dilution of the fuel-air mixture in the intermediate tube portion **27** with combustion gases from the combustion chamber **11** can not take place.

The construction according to the present invention will provide a stable operation of the pulse jet burner and will assure that fuel gases with different heat contents, different ignition speeds and different reaction times are burned substantially in the same perfect manner.

It will be understood that each of the elements described above, or two or more together, many also find a useful application in other types of pulse jet burners differing from the types described above.

While the invention has been illustrated and described as embodied in a pulse jet burner having mixing tube means in which a rotary movement is imparted at least to the air stream passing therethrough so as to provide an intimate mixing of the air and fuel streams passing through the mixing tube means, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. In a valveless pulse jet burner, in combination, at least one combustion chamber; mixing tube means for feeding a mixture of combustion air and fuel into said combustion chamber, said mixing tube means comprising outer tube means communicating at one end thereof with the combustion chamber a sleeve having a diameter smaller than the outer tube means and being coaxially arranged in the latter so as to define between the inner surface of the outer tube means and the outer surface of the sleeve and annular gap, said sleeve having one end axially spaced from said one end of the outer tube means, means closing said annular gap at the other end of that sleeve, a first conduit communicating with said other end of that sleeve for feeding combustion air into the latter, a second conduit communicating with the annular gap for feeding fuel into the latter, and means located in its entirety in said sleeve for imparting to the combustion air passing therethrough a twisting movement to provide an increased mixing action between combustion air and fuel in the space between said one end of the sleeve and said one end of the outer tube means; and a resonance duct communicating with the interior of said combustion chamber spaced from said one end of said outer tube means.

2. In a pulse jet burner as defined in claim **1**, wherein said means for imparting a twisting movement to the combustion air comprises a spirally wound sheet metal member in said sleeve.

3. In a pulse jet burner as defined in claim **2**, wherein said spirally sheet metal member extends through the whole length of said sleeve and is twisted at least through an angle of 90 degrees.

4. In a pulse jet burner as defined in claim **1**, and including means dividing said annular gap into two longitudinal extending compartments, said second conduit communicating only with one of said compartments.

5. In a pulse jet burner as defined in claim **2**, and including a pair of diametrically opposite webs extending longitudinally through said annular gap between the inner surface of said outer tube means and the outer surface of said sleeve and dividing the annular gap into two longitudinally extending compartments, said second conduit communicating only with one of said compartments.

6. In a pulse jet burner as defined in claim **5**, wherein end portions of said webs in the region of said one end of said sleeve are bent in the same sense as the spirally wound sheet metal member in said sleeve.

7. In a pulse jet burner as defined in claim **1**, and including a calotte having a diameter smaller than said sleeve and being arranged coaxially wtih the latter in the region of said other end thereof, with the concave side of said calotte facing the interior of said sleeve.

8. In a pulse jet burner as defined in claim **1**, wherein the cross section of said annular gap at said one end of said sleeve is smaller than the cross section of the remainder of said gap.

9. In a pulse jet burner as defined in claim **1**, wherein said means for closing said annular gap are integrally connected to said sleeve and together with the latter exchangeably mounted in said outer tube means.

10. In a pulse jet burner as defined in claim **1**, wherein said outer tube means comprises in the region of said sleeve an intermediate tube portion releasably connected to said first conduit.

11. In a pulse jet burner as defined in claim 1, wherein said resonance duct communicates with one end of said combustion chambers substantially coaxially therewith and said mixing tube means communicates with said combustion chamber in the region adjacent to the other end thereof and extends transverse to the axis of said combustion chamber.

References Cited

UNITED STATES PATENTS

2,719,580	10/1955	Haag et al.	431—1
3,227,202	1/1966	Morgan	431—353
3,252,496	5/1966	Haag	431—1

EDWARD G. FAVORS, Primary Examiner