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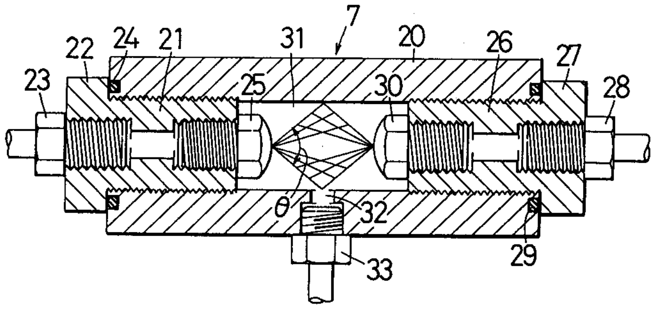
(54) **Activated, ionized fuel and apparatus for producing the same as well as combustion system for the same.**

(57) An activated, ionized fuel which allows a reduction in the generation of nitrogen oxides is produced by an apparatus having an extremely simple structure, and combustion of the activated, ionized fuel is realized by a combustion system. Both a liquid fuel injection valve (25) and a water injection valve (30) inject a liquid fuel and water toward a mixing-stirring chamber (31). The liquid fuel and water injected opposite to each other are mixed together by stirring in the mixing-stirring chamber (31), thereby being activated, ionized as well as emulsified. Since it has been activated, ionized as well as emulsified, the fuel is highly combustible and allows a reduction in the content of nitrogen oxides in the exhaust gas.

FIG. 2



Activated ionized fuel OUT

EP 0 581 230 A2

1. Field of the Invention

The present invention relates to an activated, ionized fuel formed by mixing together water and a liquid fuel, and also relates to an apparatus for producing the activated, ionized fuel as well as a combustion system for the activated, ionized fuel. More particularly, the present invention relates to an apparatus for producing an activated, ionized fuel by mixing together a liquid fuel and water by a special method. The present invention also relates to an antipollution and highly efficient combustion system for realizing combustion of the activated, ionized fuel produced by the above-described apparatus.

2. Background of the Invention

Burning appliances are used alone or in combination with a combustion chamber. The most important function required is to completely burn the fuel supplied thereto. That is, it is desirable for the combustion efficiency to be as close to 100% as possible. Therefore, the flame size and pattern during combustion must be conformable to various conditions, and the combustion load factor must be of appropriate value. Under certain circumstances, the flame temperature distribution is demanded to be uniform or to show a desired pattern.

Furthermore, there has recently been a strong social demand for minimizing the generation of air pollutants, e.g., nitrogen oxides, smoke dust, carbon monoxide, etc., and of noise. For example, B fuel oil and C fuel oil are generally used as fuel for boilers and furnaces. However, crude oil, naphtha, kerosene, etc. are also used these days because sulfur oxides (SO_x) and nitrogen oxides (NO_x) in the exhaust gas cause serious problems. The SO_x content in the exhaust gas depends upon the sulfur content in the fuel.

Accordingly, as the regulation of SO_x in the exhaust gas becomes stringent, it has become necessary to lower the sulfur content in the fuel used. To cope with this situation, the conventional practice has been to use crude oil having a low sulfur content, to install a crude oil desulfurization system or an exhaust gas desulfurization system, or to change fuel. However, the lowering of the sulfur content in crude oil has almost reached the limit. In the meantime, NO_x in the exhaust gas is mainly formed by combustion. In the combustion reaction, organic compounds and nitrogen in ammonia, which are contained in the fuel, are converted into NO_x. It is said that the conversion ratio is generally 30% to 60% in the case of industrial combustion apparatuses.

NO_x is also formed from nitrogen in the air supplied for combustion. Burning appliances are generally composed of a fuel supply system and an air supply system. The main part of the fuel supply system is a fuel injection device which injects fuel with appropriate momentum. In the case of a liquid fuel, it is atomized and dispersed by a fuel injection device. The main part of the air supply system is an air resister which effectively mixes combustion air with the fuel injected and stabilizes the flame in the stream of air. The air resister further has a function of regulating and controlling the air stream in order to control combustion characteristics. That is, air must be positively supplied to the combustion zone at an optimal rate.

Burning appliances that burn liquid fuel are generally called "oil burners", which are classified into spray type oil burner and vaporizing type oil burner. In the spray type oil burner, fuel is atomized into a large number of oil particles having a small diameter before burning in order to maximize the surface area of the fuel per unit volume, i.e., specific surface area of the fuel. Therefore, the spray type oil burner can burn even a heavy gravity fuel, although the combustion load factor cannot be raised to a very high level. In contrast to this, the vaporizing type oil burner vaporizes fuel by making use of a high-temperature body surface.

Recently, the global environmental problems have become a matter of great concern, and there has been an increasing demand for reduction in the generation of nitrogen oxides (NO_x). Among various methods which have been proposed to reduce nitrogen oxides (NO_x) is an oxygen-added emulsion fuel supply method disclosed in Japanese Patent Application Laid-Open (KOKAI) No. 61-91407. In this method, water and either air containing oxygen at a high concentration or pure oxygen are mixed together, and the resulting mixture is further mixed with a part or the whole of a hydrogen oxide system fuel and then supplied to combustion equipment.

This system suffers, however, from the problem that it is necessary to supply pure oxygen or air containing oxygen at a high concentration. If air is used, the amount of nitrogen oxides produced increases under the influence of nitrogen in the air. In addition, the system needs to incorporate a complicated circuit. There have also been proposed a great variety of methods for mixing only water or steam with fuel (for example, Japanese Patent Application Laid-Open (KOKAI) Nos. 52-25807 and 63-148012, and many others). Furthermore, there have been a great variety of apparatuses for producing an emulsion from water and oil (for example, U.S. Patent Nos. 4,416,610 and 3,648,714). However, emulsions produced by these apparatuses are not ionized, as described later, and the apparatuses are complicated.

The present inventor proposed an apparatus for producing an emulsion by using an agitating element incorporating a magnet (PCT/JP91/00776). However, this emulsion producing apparatus inevitably involves a complicated structure because it uses a rotor blade and a magnet. Furthermore, the energy that is used to drive the rotor blade during the production process cannot effectively be converted for the fuel produced. That is, the energy loss during the production of the fuel cannot be disregarded. The present invention realizes an activated, ionized fuel, which is presumed to be approximately similar to the emulsion produced by the apparatus proposed in the above-described application, by an apparatus having an extremely simple structure.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an apparatus for producing an activated, ionized fuel, which allows a reduction in the generation of nitrogen oxides, by an extremely simple structure, and also provide a combustion system for the activated, ionized fuel.

The present invention provides an activated, ionized fuel which is an emulsion of water and a hydrocarbon system liquid or solid fuel. The activated, ionized fuel includes finely divided particles of the liquid or solid fuel, and clusters of water formed around the liquid or solid fuel particles to form micelles constituting a lyophilic colloid. The water is excited to cause a bearing movement, which is a rotational movement, of active-water clusters.

The activated, ionized fuel is produced by an apparatus which includes a liquid fuel tank for storing a liquid fuel, a liquid fuel pump for pressurizing the liquid fuel, a water tank for storing water, a water pump for pressurizing the water, a mixing-stirring chamber having a compartmental space supplied with the liquid fuel and water from the liquid fuel and water tanks, a water injection valve disposed at one end of the mixing-stirring chamber to inject the pressurized water in the form of spray, and a liquid fuel injection valve disposed at the other end of the mixing-stirring chamber opposite to the water injection valve to inject the pressurized fuel.

The activated, ionized fuel is burned in a combustion system which includes an activated, ionized fuel pump for pressurizing the activated, ionized fuel produced from the liquid fuel and water and taken out from the mixing-stirring chamber, and a burner for atomizing and injecting the activated, ionized fuel supplied from the activated, ionized fuel pump.

Preferably, the combustion system further includes a combustion unit for burning the fuel supplied from the burner. The combustion unit is formed with a plurality of slits and has a space defined therein.

The combustion unit may have a spherical space defined therein and further have a double-wall structure including a pair of inner and outer walls.

The present invention has an advantage in that an activated, ionized fuel can be produced by an apparatus having an extremely simple structure.

Another advantage of the present invention is that the activated, ionized fuel produced by the apparatus of the present invention can effectively be burned without the need for positively supplying air, and it is therefore possible to realize a marked reduction in the NO_x content in the combustion gas.

Still another advantage of the present invention is that if the activated, ionized fuel is burned in the combustion system of the present invention, a high heat transfer coefficient is obtained because the combustion gas contains a large amount of steam.

Both the liquid fuel injection valve and the water injection valve inject a liquid fuel and water toward the mixing-stirring chamber. The liquid fuel and water injected opposite to each other are mixed together by stirring in the mixing-stirring chamber, thereby becoming activated and ionized. The pump sucks the fuel, which has been activated, ionized as well as emulsified, from the mixing-stirring chamber and sends it to the burner under pressure. The burner atomizes and sends the fuel into the inner combustion unit. Since the inner combustion unit has been preheated, the fuel begins to burn with ease by virtue of the preheating. During the combustion, it is not necessary to send air positively. The fact that the two liquids have been activated, ionized as well as emulsified means that the fuel has ionization energy and hence it is in a highly combustible state when it is burned.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a functional block diagram showing an outline of the combustion system according to the present invention.

Fig. 2 is a sectional view of an essential part of a mixing-stirring mechanism.

Fig. 3 is a perspective view showing the external appearance of an inner combustion unit.

Fig. 4 is an exploded perspective view of the inner combustion unit.

Fig. 5 is a sectional view taken along the line V-V in Fig. 3.

Fig. 6 shows another embodiment of the present invention in which the inner combustion unit is formed as a spherical double-wall furnace core.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Outline of Combustion System

One embodiment of the present invention will be described below with reference to the accompanying drawings. Fig. 1 is a block diagram showing an outline of the combustion system. A first liquid fuel tank 1 is a tank for storing a liquid fuel used to preheat an inner combustion unit 16 (described later). This liquid fuel is sent through a cock 18a to an activated, ionized fuel pump (not shown) in a burner 15. The activated, ionized fuel pump pressurizes the liquid fuel to send it to a fuel injection valve 18.

A second liquid fuel tank 2 is stored with a liquid fuel for combustion. A water tank 3 is stored with water which is to be mixed by stirring with the liquid fuel from the second liquid fuel tank 2 by a method (described later). The liquid fuel in the liquid fuel tank 2 is supplied to a fuel mixing-stirring mechanism 7 through a pipe via a liquid fuel pump 4, a flow control valve 5 and a flowmeter 6.

The liquid fuel pump 4 pressurizes the liquid fuel. The flow control valve 5 controls the flow rate of the liquid fuel sent to the fuel mixing-stirring mechanism 7. The flowmeter 6 measures the flow rate of the liquid fuel. The water in the water tank 3 is supplied to the fuel mixing-stirring mechanism 7 through a pipe via a water pump 8, a flow control valve 9 and a flowmeter 10.

The water pump 8 pressurizes the water from the water tank 3. The flow control valve 9 is a valve for controlling the flow rate of water to be sent to the fuel mixing-stirring mechanism 7. The flowmeter 10 measures the flow rate of the water. The liquid fuel and water, which are supplied to the fuel mixing-stirring mechanism 7 from the second liquid fuel tank 2 and the water tank 3, are mixed together by a method (described later), thereby being activated, ionized as well as emulsified. The mixture of the water and the liquid fuel, which has been activated, ionized as well as emulsified in this way, is sucked from the fuel mixing-stirring mechanism 7 by a pump 12 through a cock 11 and then pressurized so as to be supplied to the burner 15 and injected into an outer combustion chamber 17 through a fuel injection valve 19.

A pressure gauge 13 is an instrument for measuring and monitoring the delivery pressure of the activated, ionized fuel pump 12 so as to maintain the pressure at a constant level. A flowmeter 14 measures the flow rate of the fuel activated, ionized as well as emulsified, which is supplied to the burner 15 from the activated, ionized fuel pump 12. The burner 15 has fuel injection valves 18 and 19 each injecting fuel through an orifice at high speed under pressure, thereby atomizing it. The burner 15 further has a blower.

The burner 15 has a known structure. Therefore, the structure thereof will not be detailed herein. In this embodiment, two injection valves, that is, the fuel injection valve 18 for preheating and the fuel injection valve 19 for combustion, are disposed. The preheating fuel injection valve 18 and the blower are used only to preheat the inner combustion unit 16. The activated, ionized fuel, atomized by the fuel injection valve 19, burns in the inner combustion unit 16 to heat the outer combustion chamber 17.

Fuel Mixing-Stirring Mechanism 7

Fig. 2 is a sectional view of the fuel mixing-stirring mechanism 7. The fuel mixing-stirring mechanism 7 has a cylindrical body 20 whose diameter and length are approximately equal to each other. A plug member 21 is screwed into one end surface of the body 20. A pipe joint 23 is screwed into the rear end of the plug member 21. An O-ring 24 is disposed between a flange 22 of the plug member 21 and the end surface of the body 20 to seal the area between the plug member 21 and the body 20. A liquid fuel injection valve 25 is screwed into the distal end of the plug member 21.

Similarly, a plug member 26 is screwed into the other end surface of the body 20. A pipe joint 28 is screwed into the rear end of the plug member 26. An O-ring 29 is disposed between a flange 27 of the plug member 26 and the end surface of the body 20 to seal the area between the plug member 26 and the body 20. A water injection valve 30 is screwed into the distal end of the plug member 26.

A cylindrical mixing-stirring chamber 31 is defined in a space inside the body 20 which is surrounded by the liquid fuel injection valve 25 and the water injection valve 30. A discharge opening 32 for radially discharging the activated, ionized fuel is provided in the peripheral wall of the middle of the body 20. A pipe joint 33 is connected to the discharge opening 32. The liquid fuel injection valve 25 and the water injection valve 30 respectively inject the liquid fuel and water simultaneously toward the mixing-stirring chamber 31.

It should be noted that the body 20, the plug members 21 and 26, the liquid fuel injection valve 25, the water injection valve 30, the pipe joints 23 and 28, etc. may be formed of a magnetic material. However, it is preferable to use a non-magnetic material, e.g., a ceramic material, a stainless steel, etc. The angle θ of injection of the liquid fuel injection valve 25 and the water injection valve 30 is preferably in the range of from about 30° to about 60°. The pressure for the injection is preferably in the range of from 5 kg/cm^2 to 10 kg/cm^2. Furthermore, if a magnet is disposed in the vicinity of the pipe joint 28 used to supply water, the efficiency of production of the activated, ionized fuel is improved.

Inner Combustion Unit 16

The activated, ionized fuel, formed from the liquid fuel and water in the fuel mixing-stirring mechanism 7, is sucked and pressurized by the activated, ionized fuel pump 12 so as to be supplied to the fuel injection valve 19 in the burner 15. The burner 15 injects the activated, ionized fuel into the inner combustion unit 16 in the form of spray. Fig. 3 shows the external appearance of the inner combustion unit 16. Fig. 4 is an exploded perspective view of the inner combustion unit 16. Fig. 5 is a sectional view taken along the line V-V in Fig. 3. The inner combustion unit 16 has a double-tube structure comprising an outer combustion tube 40 and an inner combustion tube 41.

The outer and inner combustion tubes 40 and 41 have a cylindrical configuration. These combustion tubes 40 and 41 each have a plurality of slits 42 opened in the peripheral surface thereof. Since the outer diameter of the outer combustion tube 40 is larger than that of the inner combustion tube 41, an air gap 42 is formed between the two combustion tubes 40 and 41. The activated, ionized fuel burns in the air gap 42 and in the space outside the outer combustion tube 40, that is, in the outer combustion chamber 17, which serves as a combustion furnace.

Operation

In actual use, the above-described activated, ionized fuel producing apparatus and activated, ionized fuel combustion system operate as follows: First, the liquid fuel is supplied from the first liquid fuel tank 1 to the built-in pump (not shown) in the burner 15 through the cock 18a. In this embodiment, commercially available kerosene is used as the liquid fuel. The built-in pump in the burner 15 pressurizes the liquid fuel to send it to the fuel injection valve 18. The fuel injection valve 18 atomizes the liquid fuel supplied under pressure and sends the atomized fuel to the inner combustion unit 16. The atomized fuel injected into the inner combustion unit 16 is ignited by an igniter (not shown).

The liquid fuel begins to burn with the aid of air sent by the blower, thereby preheating the inner combustion unit 16 by the heat of combustion. When the inner combustion unit 16 has sufficiently been heated by the preheating process, the cock 18a is closed to cut off the supply of the liquid fuel from the first liquid fuel tank 1. Before the cock 18a is closed, the pumps 5 and 8 are started. Consequently, both the liquid fuel injection valve 25 and the water injection valve 30 simultaneously inject the liquid fuel and water toward the mixing-stirring chamber 31. The liquid fuel and water injected opposite to each other are mixed together by stirring in the mixing-stirring chamber 31, thereby being activated, ionized as well as emulsified.

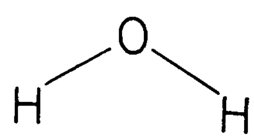
When the cock 11 is opened after the cock 18a has been closed, the activated, ionized fuel pump 12 sucks the activated, ionized fuel, formed from the water and liquid fuel activated, ionized as well as emulsified, and pressurizes it (about 8 kg/cm^2 in this embodiment) to send the fuel to the burner 15. The activated, ionized fuel sent to the burner 15 is atomized and sent into the inner combustion tube 41 of the inner combustion unit 16. Since the inner combustion unit 16 has been preheated, the activated, ionized fuel begins to burn with ease. During the combustion, it is not necessary to send air positively by the blower, but natural draft or draft close to it will suffice.

The fact that the two different kinds of liquid have been activated and ionized means that the resulting mixture has ionization energy and hence the fuel is in a highly combustible state when it is burned. Further, since the activated, ionized fuel is in the form of an emulsion in which water and oil molecules are dispersed as colloidal particles or smaller particles, it is sufficiently combustible to perform complete combustion. Accordingly, continuous combustion can be realized by natural draft without the need for positively supplying air into the inner combustion unit 16.

Combustion Principle

The principle of the continuous combustion is presumed as follows.

As is well known, H_2O (water) is a dipole. That is, the distance from the oxygen atom (O) to the proton is 0.99 Å, and the distance from the oxygen atom (O) to e^- (electron) is also 0.99 Å. Thus, the opposite charges are in equilibrium.



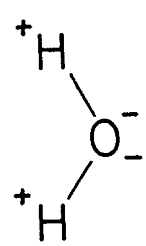
It is known that the oxygen atom (O) and the hydrogen atom (H) are covalently bonded to each other, and the angle between the two covalently bonded hydrogen atoms (H) is 105°3′.

The term "cluster" means a state in which some particles in a many-particle system are locally correlated to each other. The dynamic molecular group structure (i.e., a kind of cluster) repeats separation and formation at a speed of 10^{-12} sec. If water is given electric charge of e^- (electrons) to raise the electric charge of the bivalent ion O (oxygen atom), the protons are attracted to e^- (electrons), so that the angle between the two atoms becomes larger than 105°3′.

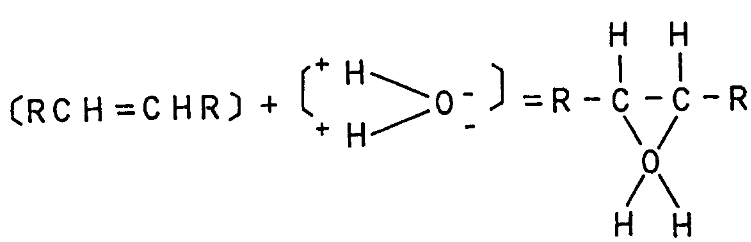
See Fig. 7

The protons are affected by the amount of electric charge of e^- (electrons) and incessantly repeat small oscillation to return to the previous position. That is, the dipole efficiency is raised by applying external force to water to thereby raise the electric charge. As a result, the water is excited, and the dynamic molecular group structure (cluster) is divided into smallest units, which repeat formation and separation at a higher density and at a speed higher than 10^{-12} sec, thus showing Brownian movement.

If the excited water

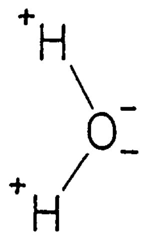


is physically micro-blended with an olefin system unsaturated hydrocarbon (oil), that is, mixed with it in the fuel mixing-stirring mechanism 7, the reaction expressed by the following formula takes places:



This reaction is similar to a reaction occurring in the case of an ozonide compound, i.e., a compound formed by the addition of ozone to the double bond of a compound having an ethylene linkage. Thus, carbon and oxygen link together by ionic bonding to show a hydrocarbon structure having oxygen in the center, i.e., RCH_2OCH_2R.

The excited water

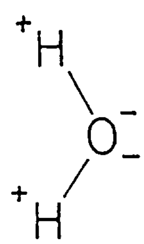


is attracted to protons by force which is 1/32 of that of hydrocarbon. That is, water dipoles are excited by the fuel mixing-stirring mechanism 7 to perform a rotational movement, referred to as "bearing movement" in this specification, regularly around the oil molecules according to the polarity in the form of very small clusters (dynamic molecular group structure). That is, active-water clusters are formed.

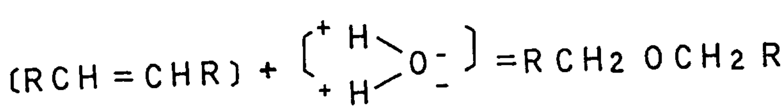
The active-water clusters whip around the oil molecules to form smallest units of micelle. That is, this micelle forms a lyophilic colloidal particle produced by association of a multiplicity (several to several tens in general) of small molecules by the action of intermolecular force, thus producing an activated, ionized fuel having the following chemical structure:
See Fig. 8

The rotational speed of the active-water dipole cluster surrounding the oil molecule is about 10^{-6} sec, which is lower than that of a cluster forming the outermost shell by an amount corresponding to a lowering in the speed caused by the attraction. A water cluster, which regularly maintains the directional properties, similarly forms an annular shell outside the above-described cluster. The rotational speed of the second cluster is about 10^{-9} sec. Another annular cluster is similarly formed outside the second cluster. Excited water molecules which are not affected by the protons perform Brownian movement, that is, random movement caused by heat, outside the micelle.
See Fig. 9

The olefin system unsaturated hydrocarbon (oil), which forms the center core, combines with the excited water



to form 1 mol of an organic substance by the following reaction:



The organic substance thus formed burns by the following reaction:

$RCH_2\ OCH_2\ R + 6O_2 = 4CO_2 + 5H_2\ O$

In the meantime, the bearing movement of active-water cluster that forms the outermost shell causes detonation of steam when the oil in the center core burns. As a result, microscopically divided water clusters are decomposed into H and O, thereby allowing the unburnt oil to burn completely. Accordingly, even if the amount of air supplied during combustion is reduced to 1/30 of that in the conventional combustion process (described later), the fuel burns satisfactorily. Moreover, the NO_x and SO_x contents in exhaust gas are also reduced in comparison to the conventional combustion process: the content of nitrogen oxides (NO_x) is reduced to 1/30 or less; and the content of sulfur oxides (SO_x) is reduced to 1/3 or less.

When 55% of water is introduced, the resulting activated, ionized fuel maintains a combustion efficiency (economized actual efficiency) of 40%. When the conventional emulsion wherein no Brownian movement is performed is observed with a microscope, it is revealed that water is merely dispersed in the oil as water droplets having a particle size of 5 μm to 50 μm, forming a colloidal dispersion. The size of steam bubbles of water droplets during the combustion of the conventional emulsion is in the range of from 60 μm to 600 μm. The evaporation heat loss is 0.08% for 1% of water added. Thus, if 5% of water is added, the heat loss in the combustion of the emulsion is as large as 0.4%. Accordingly, for the conventional emulsion, 5% or more of water cannot be added. It should be noted that the conventional emulsion has no bearing movement and does not combine with the double bond of butylene and hence cannot burn when 55% of water is introduced.

As has been detailed above, the novel activated, ionized fuel of the present invention realizes an epoch-making combustion process whereby even if 55% of water is introduced, the furnace temperature rises 40%, as described above, on the basis of the combustion theory which is totally different from that of the conventional fuel consisting of a mere emulsion.

Although in this embodiment the activated, ionized fuel producing apparatus is employed for exciting water, it should be noted that other suitable apparatus or method may also be employed for this purpose. For example, if e^- (electrons) are injected into water by using an electric field, a magnetic field, an electric discharge, a photoelectric plate, an electron gun, etc. while physically applying ultrasonic vibration of 60 Hz to 90 Hz, the dipole efficiency of the water is raised. As a result, the water is excited and activated to become ionized water. Further, although in the foregoing embodiment a liquid fuel is burned, it is also possible to burn a solid fuel, e.g., coal, as long as it is a hydrocarbon fuel. In such a case, it is preferable to employ a solid fuel divided into particles having a particle size of the order of several microns, preferably not larger than 5 μm. The ionized water is mixed with an olefin system hydrocarbon by physical external force, e.g., an ultrasonic wave, or pressure, or using a Microrender (trade name).

In the case of a solid fuel also, an activated, ionized fuel can similarly be produced by the above-described apparatus. In this case, the solid fuel is used in the form of a suspension prepared by dispersing solid fuel particles in water. Preferably, a proper stabilizer is mixed with the suspension.

Experimental Data

Kerosene and an activated, ionized fuel produced by the system of the present invention were actually burned to measure nitrogen oxides (NO_x) and sulfur oxides (SO_x) in the respective exhaust gases. Experimental data obtained by the measurement will be shown below.

The combustion unit (hereinafter referred to as "furnace core") 16 was a cylindrical member having an outer diameter of 270 mm and a length of 550 mm. As a material, chrome-molybdenum steel (Japanese Industrial standard, SCM415) was used. The combustion chamber (hereinafter referred to as "furnace") 17 had a height of 1,000 mm, a depth of 950 mm, and a width of 1,100 mm. The outer wall of the furnace was heat-insulated by refractory bricks.

Table 1

	① kerosene core temp. 1025°C furnace temp. 390°C	② activated, ionized fuel core temp. 850°C furnace temp. 610°C
Nitrogen oxides (NO_x)	10 ppm	1 ppm or less
Sulfur oxides (SO_x)	20 ppm or less	20 ppm or less

In the combustion experiment, a duct whose air inlet was closed was attached to the system, and the flow rate of air flowing through the duct was also measured. As a result, ① when kerosene was burned, the air flow rate was 2.2 m^3/min., whereas, ② when the activated, ionized fuel was burned, the air flow rate was 0.073 m^3/min.

Therefore, if the amount of air used for combustion of kerosene only is assumed to be 100%, the amount of air used for combustion of the activated, ionized fuel is 3.3%. Accordingly, it will be understood from the values shown in Table 1 that the contents of nitrogen oxides (NO_x) and sulfur oxides (SO_x) in the exhaust gas generated when the activated, ionized fuel is used are practically reduced to about 1/30 of that in the case of kerosene.

It should be noted that this numerical value was calculated from the results of the measurement shown in Table 1 and the amount of exhaust gas produced by the combustion and hence includes errors in the measurement.

Embodiment 2 of Combustion Unit

Fig. 6 shows another embodiment in which the combustion unit 80 is formed as a spherical double-wall furnace core. The combustion unit 80 has an inner wall 81 and an outer wall 82 (diameter: about 300 mm). The outer peripheral surface of each wall is provided with a plurality of flame radiating openings 85. The activated, ionized fuel is supplied from the outer periphery of the inner wall 81 through a nozzle 84 having an injection angle of 60°. The supply of the activated, ionized fuel to the nozzle 84 is performed through an oil feed pipe 83. It is preferable that the injection should be carried out as close to the center of the inner wall 81 as possible, and the angle of injection of the nozzle 84 should be as large as possible.

Claims

1. An activated, ionized fuel which is an emulsion of water and a hydrocarbon system liquid or solid fuel, said activated, ionized fuel comprising:

finely divided particles of said liquid or solid fuel; and

clusters of said water formed around said liquid or solid fuel particles to form micelles constituting a lyophilic colloid, said water being excited to cause a bearing movement, which is a rotational movement, of active-water clusters.

2. An apparatus for producing an activated, ionized fuel, comprising:

a fuel tank for storing a fuel in the form of a suspension of a liquid or solid fuel;

a fuel pump for pressurizing said fuel;

a water tank for storing water;

a water pump for pressurizing said water;

a mixing-stirring chamber having a compartmental space supplied with said fuel and water from said fuel and water tanks;

a water injection valve disposed at one end of said mixing-stirring chamber to inject said pressurized water in the form of spray; and

a fuel injection valve disposed at the other end of said mixing-stirring chamber opposite to said water injection valve to inject said pressurized fuel.

3. A combustion system for burning the activated, ionized fuel of Claim 1, which may be produced by the apparatus of Claim 2, said combustion system comprising:

an activated, ionized fuel pump for pressurizing said activated, ionized fuel; and

a burner for atomizing and injecting said activated, ionized fuel supplied from said activated, ionized fuel pump.

4. An activated, ionized fuel combustion system according to Claim 3, further comprising a combustion unit for burning said fuel supplied from said burner, said combustion unit being formed with a plurality of slits and having a space defined therein.

5. An activated, ionized fuel combustion system according to Claim 3, further comprising a combustion unit having a spherical space defined therein and further having a double-wall structure including a pair of inner and outer walls.

FIG.1

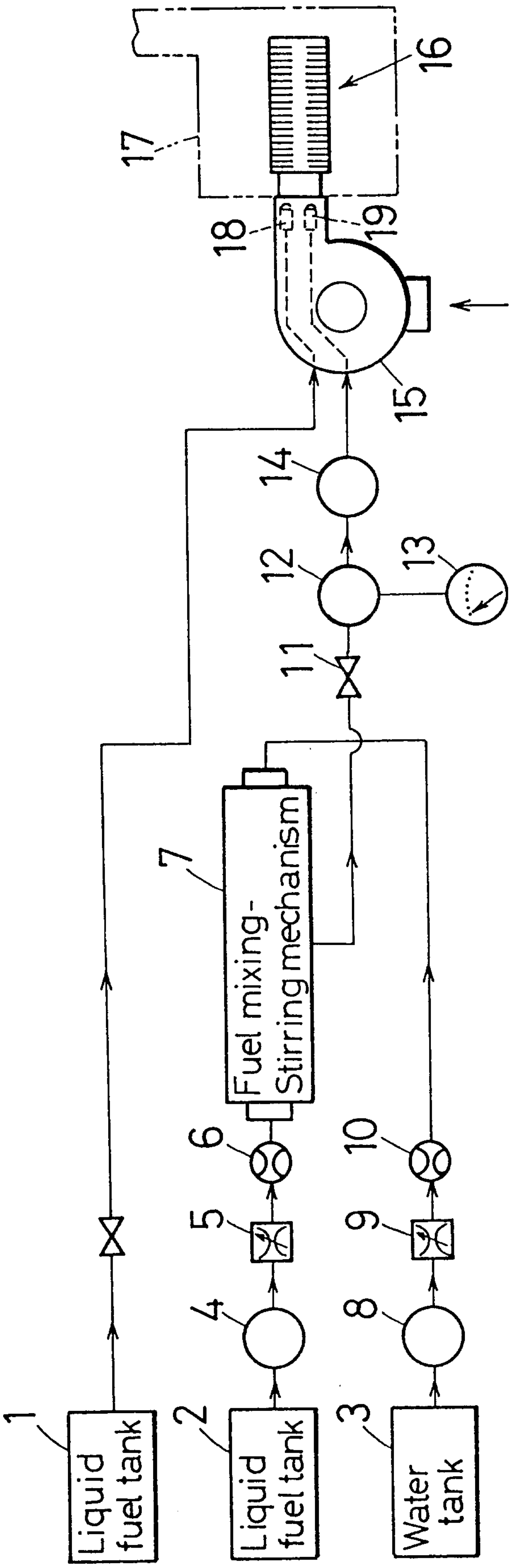
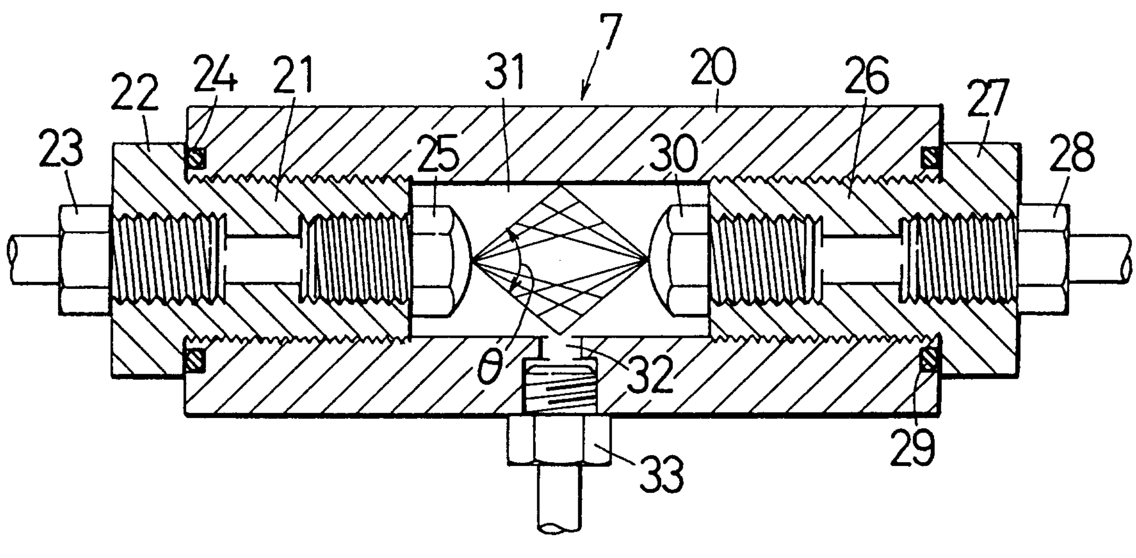

Liquid fuel tank
Liquid fuel tank
Water tank
Fuel mixing-Stirring mechanism
Air
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

FIG. 2



Activated ionized fuel OUT

FIG.3

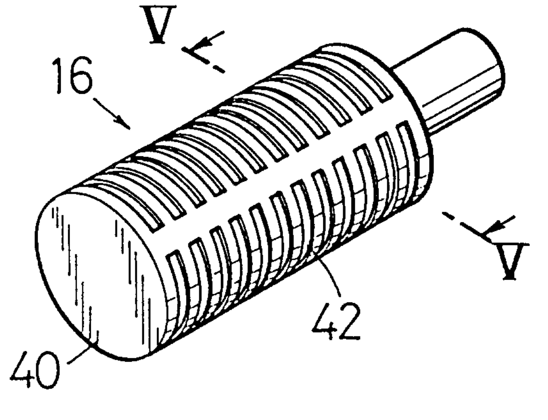


FIG.4

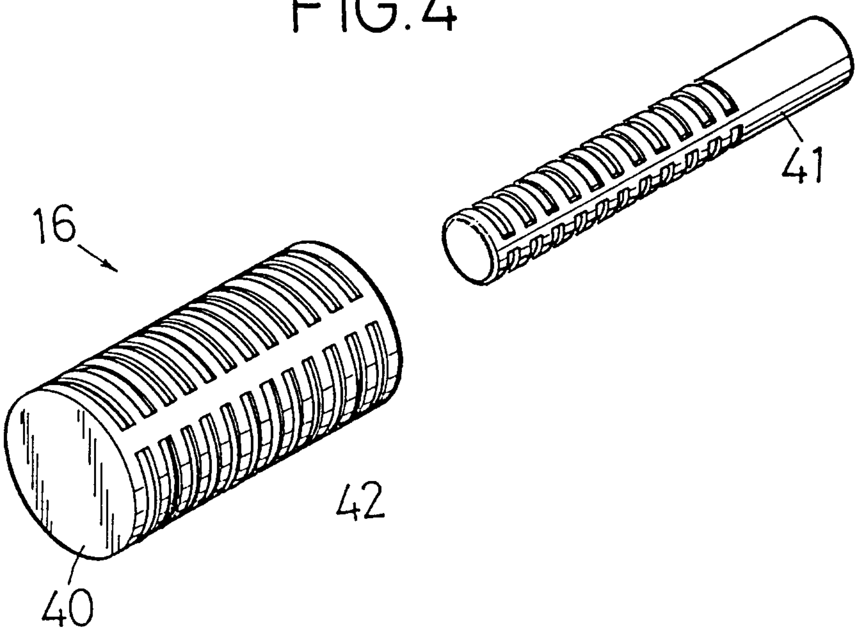


FIG.5

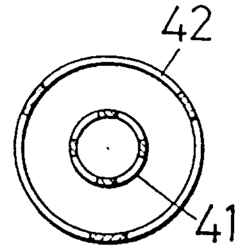
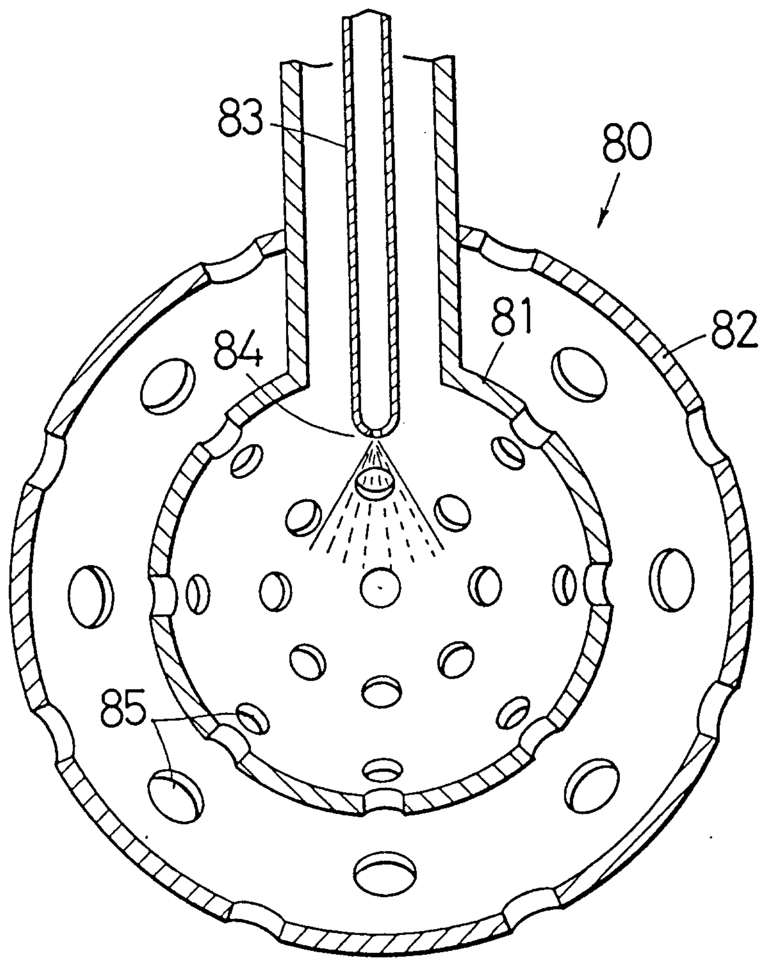


FIG. 6



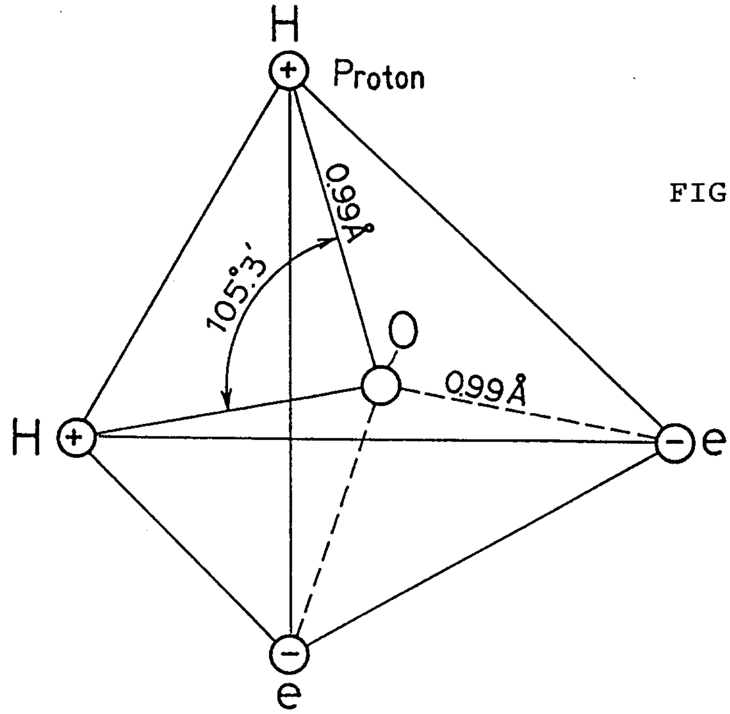


FIG. 7

FIG. 8

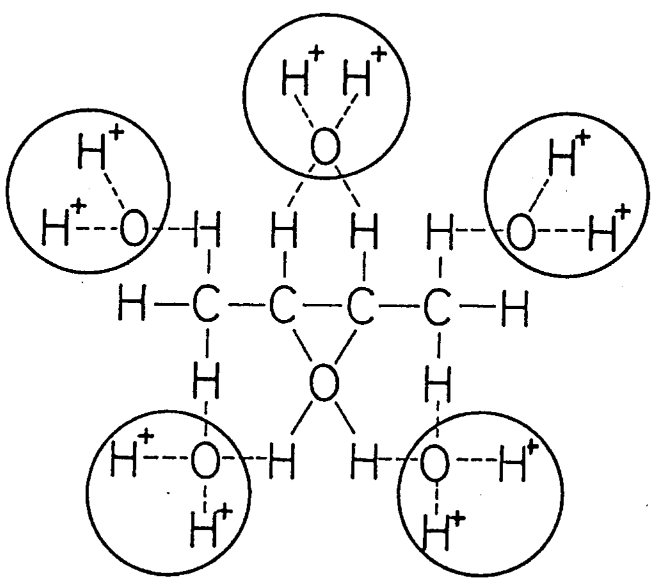
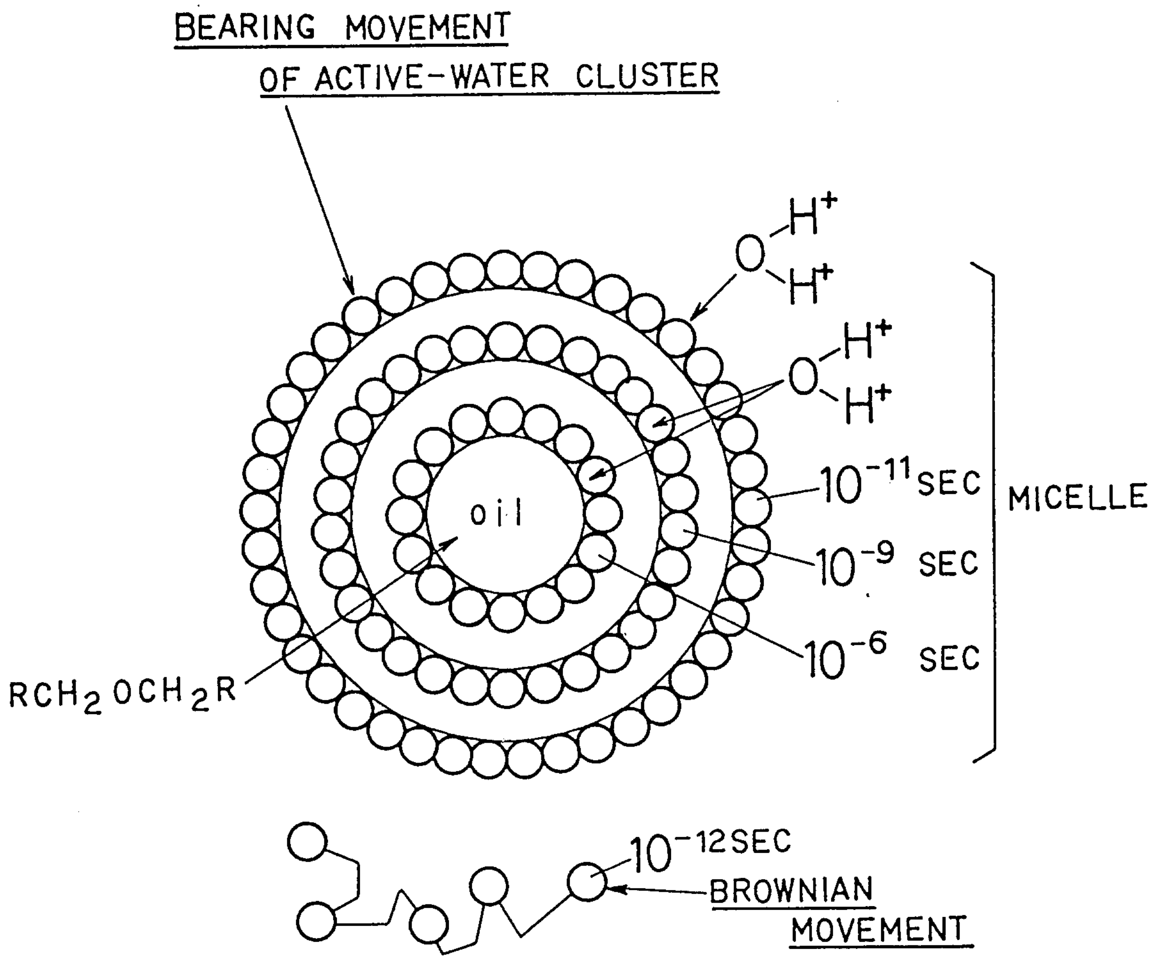


FIG. 9


BEARING MOVEMENT
OF ACTIVE-WATER CLUSTER
O-H+
H+
O-H+
H+
oil
10-11SEC
10-9 SEC
10-6 SEC
MICELLE
RCH2OCH2R
10-12SEC
BROWNIAN
MOVEMENT