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Applicant: JOHN ZINK COMPANY
4401, South Peoria
Tulsa, Oklahoma, 74103(US)

(72)

Inventor: Zink, John S.
3041 South Peoria Tulsa
Oklahoma(US)

(72)

Inventor: Reed, Robert D.
4192 South Troost Place Tulsa
Oklahoma(US)

(72)

Inventor: Goodnight, Hershel E.
1917 East 53rd Tulsa
Oklahoma(US)

(74)

Representative: Kerr, Simonne June et al,
European Patent Attorney POTTS, KERR & CO. 27, Sheet
Street
Windsor, Berkshire SL4 1BY(GB)

(54)

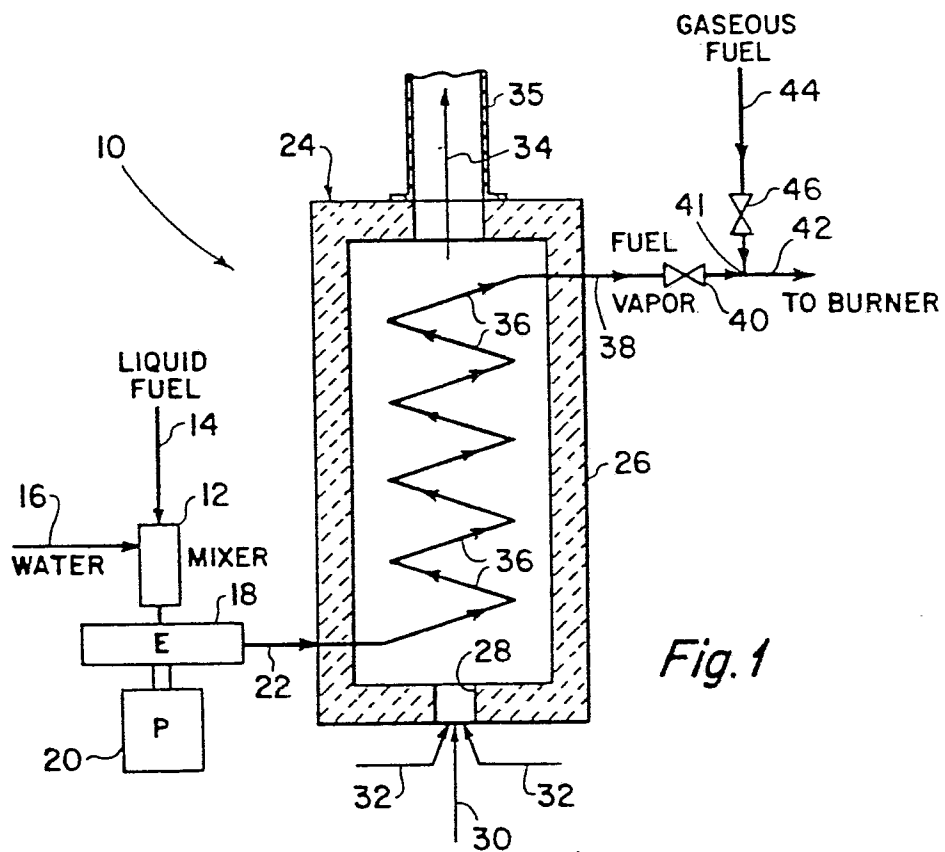
Method of burning a liquid fuel and water mixture as gaseous fuel and apparatus for carrying out said method.

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Apparatus for burning liquid fuels in a gaseous fuel burner, comprising means (12) for mixing the liquid fuel (14) and liquid water (16) in a selected ratio, subsequently heating the mixture of water and liquid fuel until both the water and the fuel are vaporized and then passing the mixture of hot fuel vapor and steam to the gaseous fuel burner.

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TITLE MODIFIED
see front page

VAPORIZED LIQUID FUEL-WATER AS GASEOUS FUEL

This invention lies in the field of liquid and gaseous fuels and fuel burners. More particularly, it concerns the method of preparation or modification of liquid fuels so that they can be vaporized and burned in a normal gaseous fuel burner.

Still more particularly, it concerns the design of a fuel system which can utilize liquid fuel and water to provide a vaporized liquid fuel-steam fuel, which can be burned alternatively with a natural gas fuel in a gaseous fuel burner.

Because of the restricted supplies of gaseous fuels, which are particularly in the natural gas category, it is at times necessary to burn liquid fuel as replacements for the normally used gaseous fuels. This is common where fuel burning is required in the operation of industry such as the chemical and petroleum industries, where all functions of production result from the application heat in some manner or other.

The prior art is illustrated by the two U.S. Patents 4,025,282 and 4,148,599. However, while they describe certain useful processes, there is a much larger field of application of the principle of liquid fuel vaporization, which is in the area of the vaporization of mixtures of liquid fuel and water, which is described in this application.

It is the primary object of this invention to provide a fuel burning system in which either gaseous or gasified liquid fuels can be burned alternatively without any change in burning equipment.

5 It is a further object of this invention to provide a liquid fuel burning system in which the liquid is fully vaporized so that it is handled identically to a gaseous fuel.

10 These and other objects are realized, and the limitations of the prior art are overcome in this invention, by providing means for mixing the liquid fuel with water in a selected ratio, heating the mixture of liquid fuel plus water until the liquid and water both are fully vaporized and produce a mixture of combustible
15 fuel vapor and steam. This gas can then be flowed alternatively with the normal gaseous fuel in the combustion apparatus.

The liquid fuel can be, for example, something like house heating oil or distillate which can be
20 directly mixed with the water or can be emulsified, so as to maintain a constant ratio mixture. The heating can be accomplished in a fuel-fired furnace, or in a heat transfer apparatus, utilizing waste heat from any available source for the supply of heat for liquid vaporization.

25 The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is a diagrammatic cross-sectional view of one embodiment of the invention; and

30 Fig. 2 is a block diagram of a simplified embodiment of the invention.

Referring now to the drawings and, in particular, to FIGURE 1, there is indicated by the numeral 10 one embodiment of the invention. A stream of water indicated by the arrow 16, and a stream of liquid fuel indicated by the arrow 14, flow into a mixer 12, which may be of conventional design. The outlet of the mixer flows into an emulsifier 18 to provide an emulsion of the liquid fuel and water, which flows by pipe 22 into a heater unit indicated generally by the numeral 24. This can be of conventional design. Illustrated in FIGURE 1 is a fuel-fired furnace 26, which is shown schematically, supplied with fuel 30 through a burner opening 28 and supplied combustion air 32, to provide a high temperature environment inside the furnace 26, to heat the internal piping 36, through which the emulsion of liquid fuel and water flows. The hot products of combustion flow in accordance with arrow 34 up the stack 35 in a conventional manner.

The outlet pipe 38 now contains a flow of vaporized liquid fuel and steam, which goes through an appropriate valve 40, and to a gas fuel line 42 to the burner. At the junction 41 another pipe joins the line 42 and supplies a gaseous fuel 44 through a valve 46. By controlling valves 40 and 46 either one or the other source of gaseous fuel can be provided to the burners.

By controlling the ratio of liquid water to liquid fuel, the partial pressure of fuel vapor to water vapor can be changed and, thus, the temperature and the heat content of the gaseous fuel can be made any desired value.

Operationwise, the liquid vapor and steam in line 38 is operatively similar to that of the conventional gaseous fuel 44, so that no mechanical changes are required in the burner to substitute one fuel for the other.

In FIGURE 2 is shown a modification of the system 10 of FIGURE 1, wherein the liquid fuel 14 and water 16 are simply mixed in the mixer 12, to form a mixture of droplets of oil and water to flow by line 50 to the heater 52.

In this case the heater is shown as a heat transfer device, rather than a furnace as in FIGURE 1. This heat transfer device can utilize waste heat from hot byproducts of other process operations, that may be available. This is shown schematically as a heat transfer device with hot fluid entering at the top through line 54 and passing down in counterflow through the mixture of liquid fuel and water, which is flowing up through pipes in the interior of the heater. The cooled hot fluid leaves through line 56.

The heated gaseous fuel now at a high enough temperature to vaporize both the liquid fuel and the water, leaves by line 38 to go to the burner as in FIGURE 1.

It is clear that the liquid fuel and water can be mixed in various ways. They can be simply mixed, or they can be emulsified to form droplets of one liquid in the other. The liquid fuel can be atomized and then mixed, or emulsified with the water, etc. The heating can be carried out in any suitable manner so as to provide the proper temperature and pressure, and so as to most efficiently utilize heat that is available.

What has been described is apparatus for the use of a mixture of liquid water and distillate oil prior to vaporization, for supply of diluent vapor for the vaporized distillate after the vaporization of both oil and water, for use as a substitute gaseous fuel, in burners designed for the burning of gaseous fuels only. In this case, the initially liquid water is vaporized along with the distillate fuel oil, to serve as diluent gas for vaporized liquid distillate oil. Dilution of vaporized distillate oil is demanded for suitable gaseous fuel calorific control, since vaporized water is free of

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calorific value. Selected quantities of oil and water are simultaneously vaporized for creation of a preferred gaseous fuel. The vaporization occurs at a selected, and suitable pressure and vaporization temperature, which is suited to the vaporization pressure, in order to maintain both oil and water in vapor-phase at delivery to burners. Partial-pressures of oil vapor and water vapor determine required temperature, as is well-known to those versed in the art.

10 An exemplary condition might be the creation of 910 btu/cu ft substitute gas at 15# gauge pressure (29.7# Absolute Pressure) using a prior mixture of typical #2 oil (house heating oil) and liquid water at a final vaporization/superheat temperature of 400F (204.4C). The calorific value at 910 btu/cu ft is based on the Lower Heating Value of the fuel. The data, per million btu for gas fuel produced per hour are as follows:

 #2 oil - 7.524 gallons or 54.9# or
 92.4 SCF as vapor.

20 Water - 5.717 gallons or 47.68# or
 1,006 SCF as vapor.

 Total gas volume - SCF - 1,098.4
 SCF/MM btu/hr at 400F
 (204.4C)

25 The data, as presented are for 910 btu/SCF LHV gas only, and they will be modified as required for other calorific value gas. The function of oil-water emulsification, as shown in FIGURE 1, can be carried out by a typical impeller-driven centrifugal pump to excellent advantage, but a typical gear-pump is not considered as satisfactory.

30 It is noted that the configuration of FIGURE 2 is the preferable form of our invention because no fuel firing is required, and the use of some already heated process fluid as a heat-medium conserves fuel through avoiding direct-firing for vaporization. The heat-medium fluid can be any which is available at suitable temperature level for oil-water vaporization at required pressure,

which is typically the case. The configuration of FIGURE 1 is next in the order of decreasing preferability due to required fuel usage. The simple mixer of FIGURE 2 can be applied to either FIGURES 1 or 2, since the function of oil-water emulsification prior to vaporization is not present.

All embodiments shown make use of the identical phenomenon, which is pre-mixture of the liquids, oil and water, prior to vaporization and superheat, for use as substitute gaseous fuel. In the emulsification step the phase of vaporization is improved.

CLAIMS:

1. A method of burning liquid fuel in an apparatus equipped with at least one orifice for normally burning combustible gases, characterized in that liquid fuel is mixed with water in a selected ratio after which it is heated until the liquid fuel and the water both vaporize, whereby a mixture of combustible fuel-vapor and steam is formed, the mixture of combustible vapor plus steam under pressure then being flowed through the orifice into a burner.
2. A method according to claim 1, characterized in that the liquid fuel is atomized into small droplets prior to its admixture with water.
3. A method according to claim 1 or 2, characterized in that the mixture of liquid fuel droplets and water are emulsified prior to their heating.
4. An apparatus for burning liquid fuel in a burner designed for gaseous fuel, characterized in that there is a single orifice gaseous fuel burner, a device (12) for mixing the liquid fuel(14) with water (16) in a selected ratio, a heater (26 or 52) for heating the mixture of liquid fuel plus water until the liquid fuel and the water vaporize whereby a mixture of combustible fuel-vapor and steam is formed and a device (38, 40, 42) for flowing the mixture of combustible fuel-vapor plus steam under pressure through the gaseous fuel burner.
5. An apparatus according to claim 4, characterized in that a device (12, Fig. 2) is provided for atomizing the liquid fuel into small droplets.
6. An apparatus according to claim 4 or 5, characterized in that a device (18) is provided for emulsifying the mixture of liquid fuel droplets and water.
7. An apparatus according to claim 4, 5 or 6, characterized in that the heating device (26) comprises a fuel fired heater.
8. An apparatus according to claim 4, 5 or 6, characterized in that the heating device (52) comprises a heat transfer apparatus.
9. An apparatus according to claim 8, characterized in that the heat transfer apparatus (52) is adapted to use the heat from already heated process related fluid.

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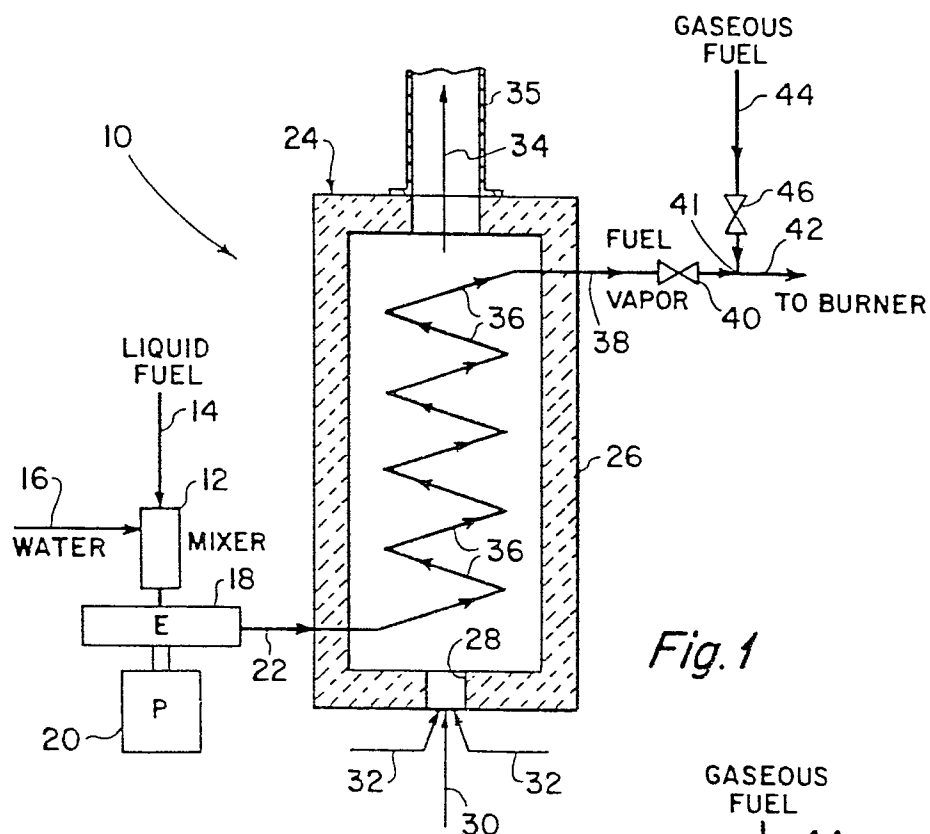


Fig. 1

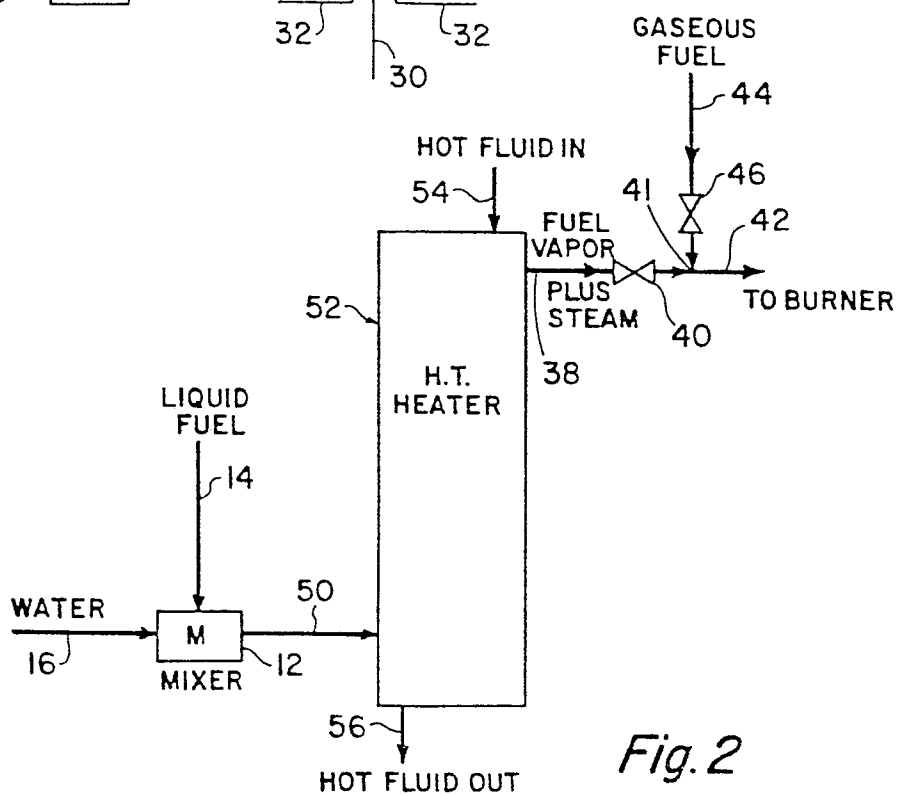


Fig. 2