LIQUID ATOMIZERS GENERATING HEAT AT VARIABLE RATE THROUGH THE COMBUSTION OF LIQUID FUEL

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FIG. 1

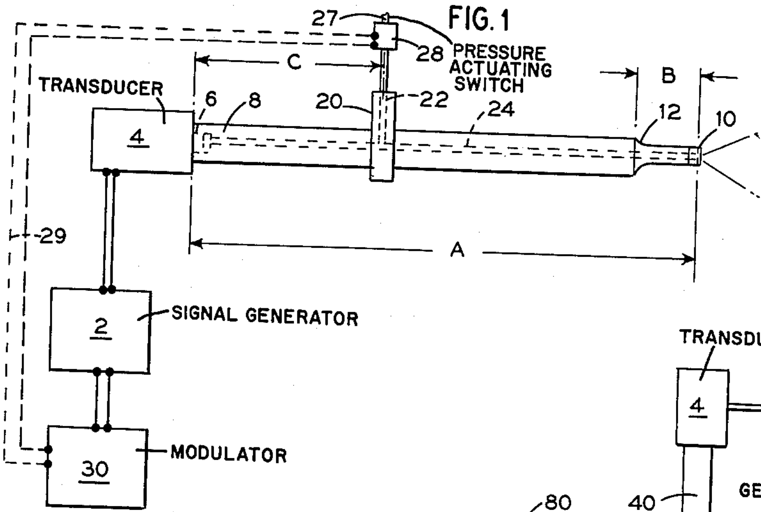


FIG. 4

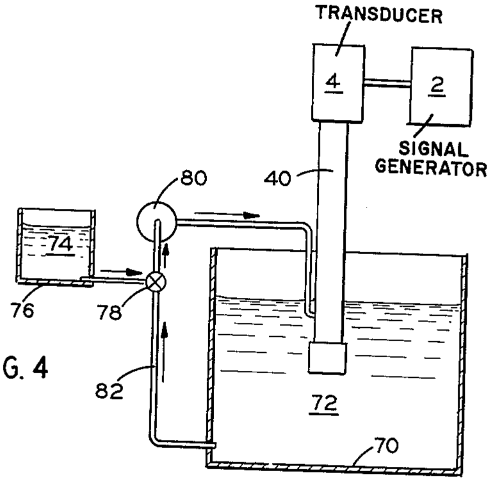


FIG. 3

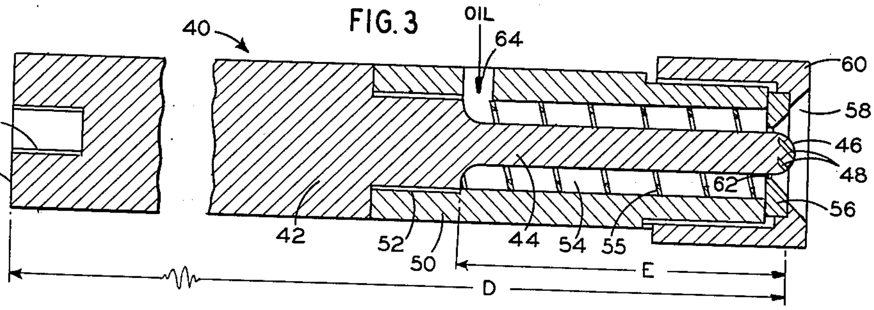
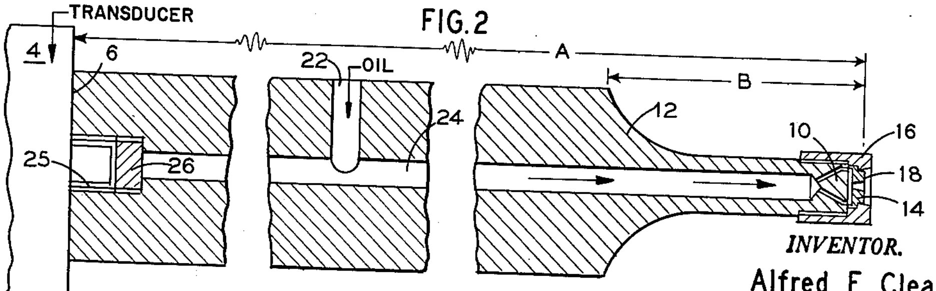


FIG. 2



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LIQUID ATOMIZERS GENERATING HEAT AT VARIABLE RATE THROUGH THE COMBUSTION OF LIQUID FUEL

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This invention relates to liquid atomizers of the kind having a discharge orifice and means for leading liquid to the orifice for discharge therethrough. While the invention may be applied to the atomization of other liquids it is of particular use for the atomization of liquid fuels.

In the operation of a liquid fuel burner of the pressure atomizing type in which the fuel leaves a whirl chamber through a discharge orifice and in which regulation of output is obtained by variation of fuel pressure, as the pressure and output are reduced the rate of whirl also decreases with the result that eventually, as the pressure and output are lowered, the atomization becomes unsatisfactory. A wider range may be obtained through the use of a return flow of the fuel from the whirl chamber as an alternative to or in addition to variation of the pressure at which the fuel is supplied, but the return flow leads to complications and further difficulties.

The present invention includes a liquid atomizer having a discharge orifice and means for leading liquid to the orifice for discharge therethrough, in which a transducer is adapted, by imparting vibrations of ultrasonic frequency to a member defining or helping to define the orifice, to effect or assist in effecting atomization of the liquid.

The present invention also includes the method of generating heat at variable rate through the combustion of liquid fuel, according to which the fuel is supplied to a pressure atomizing burner and the output of the burner is regulated by variation of the pressure of the fuel supplied to the burner while over a lower part of the range of fuel output from the burner, the burner tip is vibrated at ultrasonic frequency in such manner that the fineness of the spray is increased.

The invention furthermore includes a liquid fuel burner of the pressure atomizing type adapted to give a variable output through variation of fuel pressure, wherein a transducer is provided for imparting to the burner tip vibrations of ultrasonic frequency adapted to increase the fineness of the fuel particles during relatively low rates of fuel output from the burner.

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

FIG. 1 is a diagrammatic representation of an atomizer in the form of an oil burner arranged to be vibrated at ultrasonic frequency.

FIG. 2 is a partly diagrammatic, fragmentary, sectional elevation of a burner barrel and atomizing head.

FIG. 3 is a partly diagrammatic, fragmentary, sectional elevation of an alternative form of atomizer; and

FIG. 4 is a diagrammatic representation of an atomizer arranged to effect an emulsion of one liquid in another liquid.

Referring to FIGS. 1 and 2 of the drawings, a signal generator **2** is coupled to a magneto-strictive transducer **4** abutting the rear end face **6** of a burner barrel **8** and arranged to transmit longitudinal vibrations through the burner barrel to an atomizing head **10** at an ultrasonic frequency in the region of 20 kilocycles per second. It will be understood that, alternatively, a piezo-electric

transducer, such as a barium titanate transducer, may be used.

The burner barrel or member **8**, at the forward end thereof, includes a stepped velocity transformer **12** which has the effect of increasing the amplitude of vibrations transmitted to the atomizing head **10** situated at the end of the burner barrel **8**. The atomizing head is of conventional form and includes a spray plate **14** rigidly connected to the end of the burner barrel **8** by means of a cap nut **16**. In order to obtain maximum vibratory effect at the spray plate **14** the dimension A, namely the distance between the rear end face **6** of the burner barrel and the front face **18** of the spray plate, is an exact multiple of one-half of the wavelength of the vibrations applied to the burner barrel **8** by the transducer **4**. Any attachments to or discontinuities in the burner barrel **8** are arranged to be positioned at nodes of the vibration in order to minimize the impeding effect of such attachments or discontinuities in the transmission of the vibrations. Thus the dimension B, namely the distance of the sudden discontinuity of the velocity transformer **12** from the front face **18** of the spray plate **14**, is one-quarter of the wavelength of the applied vibration. For the same reason a mounting means **20** including an oil feed inlet **22** connecting with an axial duct **24** in the burner barrel **8** is positioned with the center thereof an exact odd multiple of one-quarter of the wavelength of the applied vibration from the rear end face **6** of the burner barrel **8**, as is indicated by the dimension C.

The burner barrel **8** is manufactured from a metal having a low acoustical impedance, such as mild steel, brass or stainless steel and is formed in one piece, the axial duct **24** being drilled from the rear face **6** towards the atomizer head **10** and the portion **25** of the duct adjacent the rear end face **6** enlarged and tapped. A plug **26** is screwed and welded into the enlarged portion **25** of the duct, the remaining section of the enlarged portion being utilized to secure the transducer **4** to the burner barrel **8** by means of a threaded stud (not shown) on the transducer.

Alternatively, the barrel **8** can be formed as two portions, the portions being welded together by a weld extending through the thickness of the material and positioned at a node in order to obtain a good acoustical coupling between the two portions.

In operation, under conditions, at or approaching the maximum rate of firing, the burner is supplied with oil at the full operating pressure and consequently good atomization of the fuel occurs, so that the ultrasonic vibrations are not required to assist in the atomization. However, upon reducing the pressure of the oil supply below a certain volume, in order to reduce the rate of firing, the atomization is unsatisfactory since the droplets become large and the spray cone becomes ill-defined but upon operating the transducer **4** to vibrate the spray plate **14**, spray droplets are formed immediately upon emergence from the spray plate and the atomization is effected again with small droplets and a well defined cone.

Thus in a test the normal operating pressure of a burner was 300 pounds per square inch with satisfactory atomization only down to 100 pounds per square inch. Upon vibrating the front face of the atomizing head the operating pressure could be lowered to 30 pounds per square inch and still maintain satisfactory atomization.

A pressure actuated switch **28** positioned in an oil supply line **27** adjacent the junction with the inlet duct **22** to the burner barrel and connected to the signal generator **2** by a circuit **29** is provided to effect operation of the signal generator **2** when the oil supply pressure is reduced below a predetermined value. Thus in the preceding example the pressure actuated switch would be set to effect operation of the signal generator 2 when the oil supply pressure is reduced below 200 pounds per square inch.

Referring to FIG. 3 of the drawings, there is shown an atomizer 40 designed to utilize the full effect of ultrasonic vibrations. Thus a body 42 is formed with a portion 44 of a reduced radius having a hemi-spherical tip 46 provided with two parallel slots or saw cuts 48 inclined at approximately 45 degrees to the axis of the body. A cylindrical chamber wall 50 is mounted upon the body 42 by means of co-acting screw threads 52 so that a cylindrical chamber 54 is formed between the portion 44 of reduced radius and the cylindrical chamber wall 50. A spiral vane 55 is positioned within the cylindrical chamber 54. A spray plate 56 having a partly frusto-conical and partly cylindrical aperture 58 is secured at the end of the cylindrical chamber wall 50 by means of a cap nut 60, the tip 46 of the portion 44 of reduced radius extending through the aperture and forming an annular orifice 62 between the tip and the spray plate. An oil fuel inlet duct 64 is arranged to discharge tangentially into the cylindrical chamber 54. The transducer 4 is secured by means of a threaded stub (not shown) against the rear end face 66 of the body 42 using a threaded hole 68.

The dimensions of the body 42 are such as to obtain a maximum vibration at the tip 46. Thus the overall length of the body between the rear end face 66 and the end of the tip 46, dimension D, is an exact number of half wavelengths of the applied vibration, while the portion 44 of reduced radius, which serves as a velocity transformer to increase the amplitude of vibrations at the tip 46, has a length, dimension E, of one-quarter of the wavelength of the applied vibration. Since the attachment of the cylindrical chamber wall 50 to the body 42 is adjacent a node the vibrations are transmitted to the cylindrical chamber wall 50 in an attenuated form. Furthermore the body and the cylindrical chamber wall are of different materials having different acoustical impedances and resonant lengths such as titanium, which also has a good fatigue strength, and mild steel, or, mild steel and brass, respectively, so that the spray plate 56 remains almost stationary relative to the tip 46.

In operation oil is fed to the cylindrical chamber 54 at a pressure ranging from a few inches head upwards and sufficient to produce the required rate of discharge, the tangential arrangement of the inlet duct 64 imparting a degree of swirl, which is increased by the vane 55 in the cylindrical chamber 54 and is discharged through the annular orifice 62 between the tip 46 and the spray plate 56. Under normal conditions such a discharge will not result in an atomized spray. However, if utrasonic vibrations are applied to the atomizer 40 by means of the transducer 4, due to the vibration of the tip 46 relative to the spray plate 56 a satisfactorily atomized spray is obtained, the two slots 48 further assisting the atomizing process in that they increase the area of the tip, and secondly they provide focal points for the atomized spray.

While the foregoing description is related to atomization of oil fuel it will be understood that other liquids may be atomized using the apparatus.

Thus as is shown in FIG. 4, the atomizer 40 described in connection with FIG. 3 is partly immersed in a tank 70 containing a first liquid 72. A second liquid 74 is contained in a further tank 76, connected to the atomizer 40 through a two-way valve 78 and circulating pump 80. In the alternative position the two-way valve connects a duct 82 extending into the bottom of the tank 72 with the circulating pump 80 and atomizer 40.

In operation, in order to form an emulsion of the second liquid 74 in the first liquid 72, the two-way valve 78 is positioned so as to connect the tank 76 with the circulating pump 80 and the second liquid 74 is discharged through the atomizer 40, which is vibrated by the transducer 4, the discharge from the atomizer producing a circulation and mixing action within the tank 70. When the desired proportional relationship between the two liquids has been attained, the position of the two-way valve 78 is adjusted to supply the liquid in the tank 70 to the circulating pump 80. The mixture within the tank 70 is then circulated through the circulating pump 80 and the atomizer 40, which is vibrated by the transducer 4, until the desired degree of emulsification is obtained.

While in accordance with the provisions of the statutes there is illustrated and described herein the best form and mode of operation of the invention now known to the inventor, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by the claims, and that certain features of the invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. A liquid fuel burner having a pressure atomizing orifice tip adapted to produce a variable output through variation of fuel pressure to said orifice at normal rates of fuel output from the burner and having a means for imparting to the burner tip vibrations of ultrasonic frequency, and means responsive to the fuel pressure to actuate said vibration means only below a predetermined pressure for enhancing the fineness of the fuel particles during relatively low rates of fuel output from the burner.

2. A burner as claimed in claim 1, including control means actuated by said fuel pressure responsive means to discontinue operation of the ultrasonic vibration producing means when the burner is discharging fuel at a rate above a predetermined value but to effect operation of said means when the burner discharges fuel at a rate below the said predetermined value.

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