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Velie

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[54] **AIR-ATOMIZING FUEL BURNER**

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[51] **Int. Cl.** **F23d 11/10**
[58] **Field of Search** 431/90, 347, 12, 8, 171; 261/78

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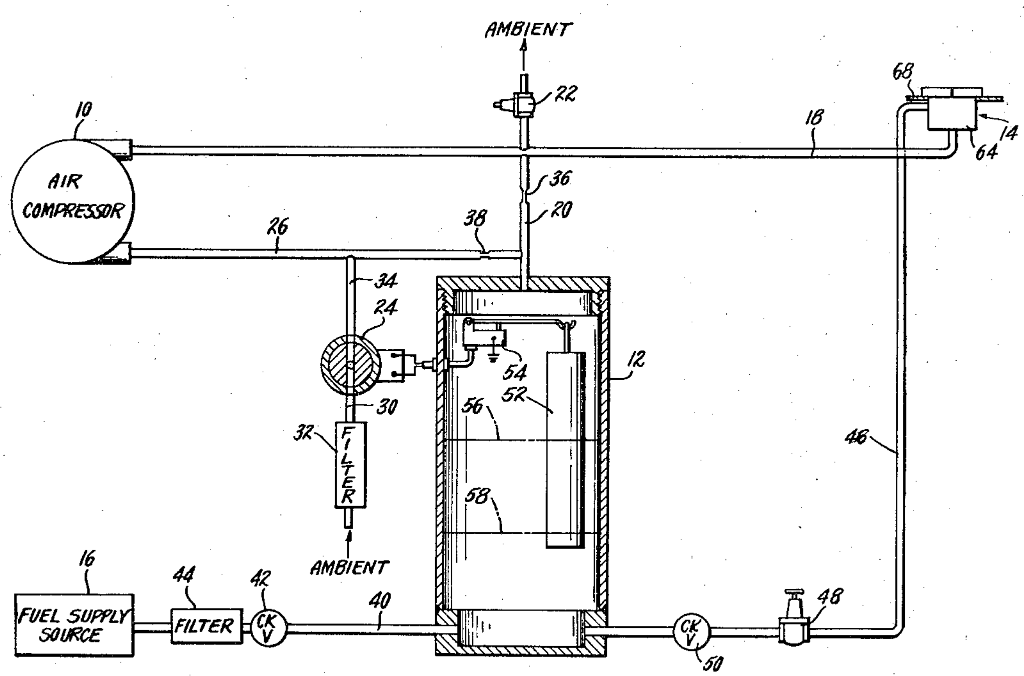
[57] **ABSTRACT**

An air-atomizing fuel burner system comprising an air compressor, a fuel reservoir and an air-atomizing nozzle. A valve is provided in the suction line of the air compressor for connecting the vacuum side of the air compressor to ambient during the burning cycle, and to the fuel reservoir during the refilling cycle. Air flow restrictors are provided in the pressure and vacuum lines from the air compressor to the fuel reservoir to control the air pressure and vacuum in the fuel reservoir. The air compressor acts to supply primary air and fuel to the nozzle during the burning cycle, and draw fuel from a remote fuel supply source during the fuel reservoir refilling cycle. A flame spreader is employed in combination with the air-atomizing nozzle according to another aspect of the invention to stabilize and shape the flame. The position and diameter of of the flame spreader are set to provide optimum fuel burning characteristics.

21 Claims, 2 Drawing Figures



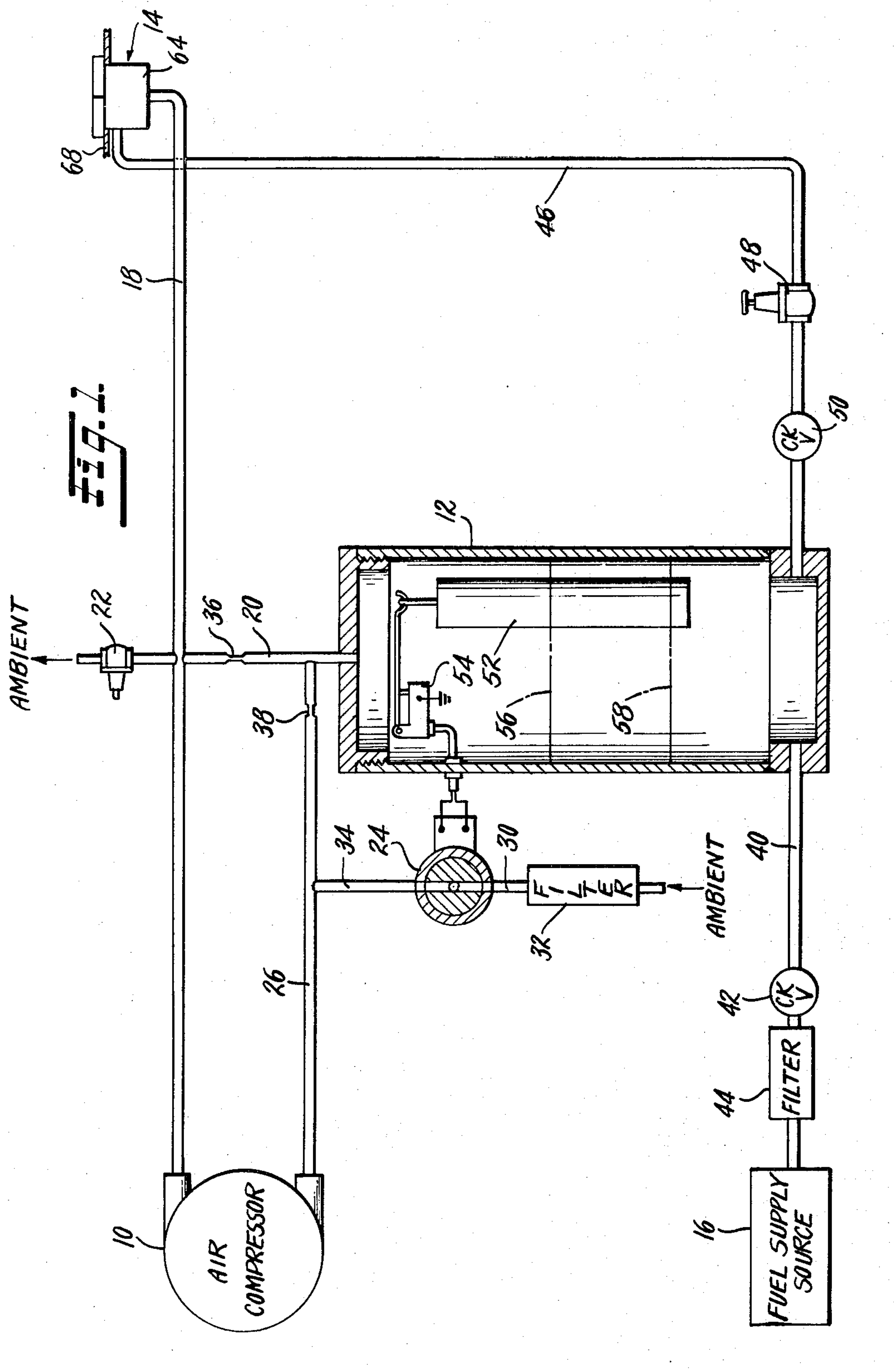

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FIG. 1

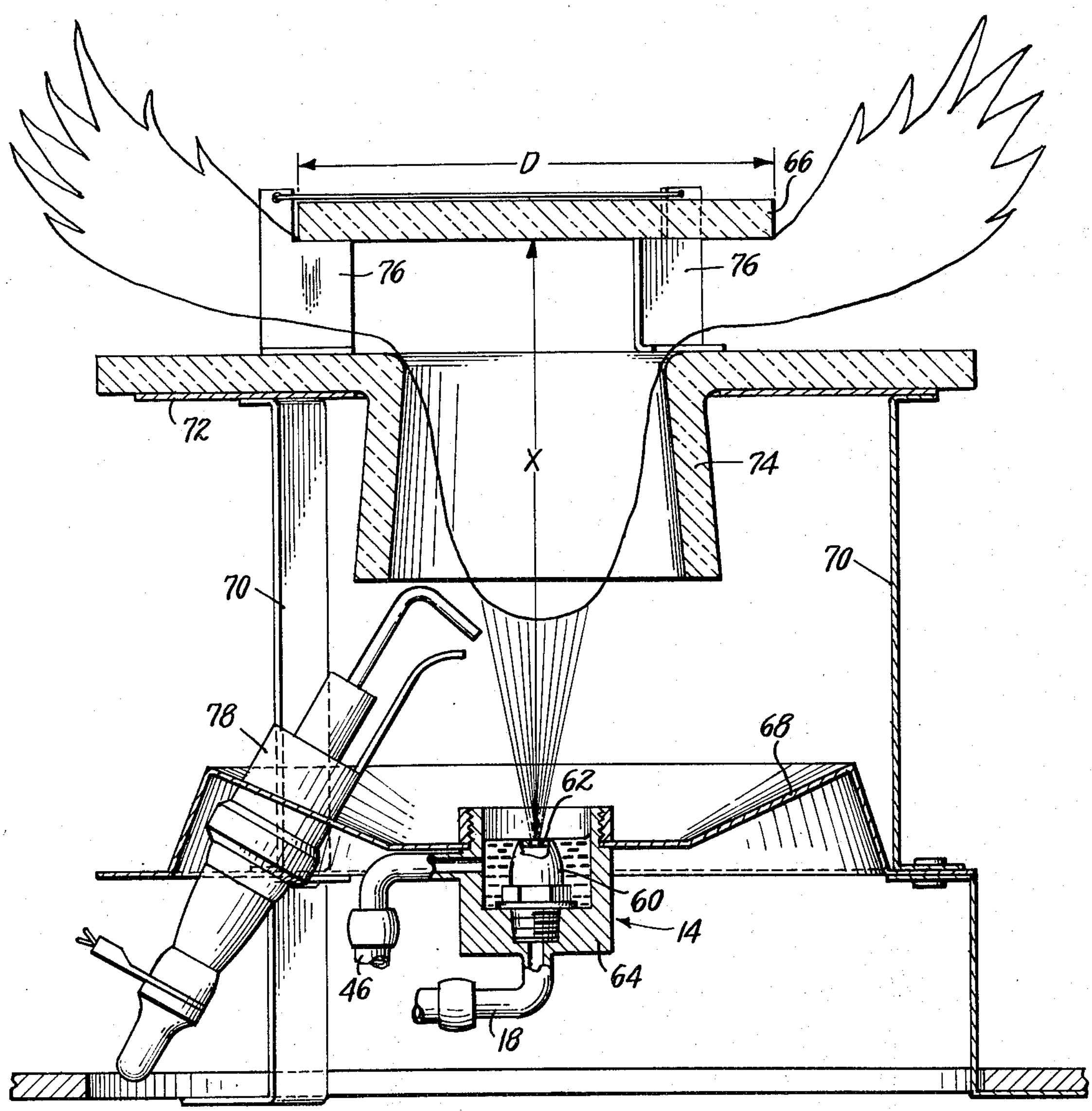

Fig. 2.

AIR-ATOMIZING FUEL BURNER

BACKGROUND OF THE INVENTION

There is an increasing interest in the use of air-atomizing fuel burners because of their combustion efficiency and cleanliness. Additionally, there is an increasing interest in air-atomizing fuel burners which can function properly at low burning rates. These air-atomizing fuel burners generally require means for supplying primary air to the air-atomizing nozzle, means for transporting fuel from a remote fuel supply source to the fuel reservoir, and means for delivering fuel from the fuel reservoir to the air-atomizing nozzle, preferably at a well controlled rate.

Accordingly, it is an object of the present invention to provide an air-atomizing fuel burner system which provides the above capabilities, and particularly one which can function properly at low burning rates.

A further object of the present invention is to provide an air-atomizing fuel burner system in which the primary air supply means is also used to deliver fuel to the air-atomizing nozzle.

A still further object of the present invention is to provide an air-atomizing fuel burner system in which the primary air supply means is also used to transport fuel from a remote fuel supply source to the fuel reservoir.

Yet another object of the present invention is to provide an air-atomizing fuel burner system in which a flame spreader is employed in combination with the air-atomizing nozzle to stabilize and shape the flame.

Still another object of the present invention is to provide an air-atomizing fuel burner system in which the position and diameter of the flame spreader are set to provide optimum fuel burning characteristics.

Still further objects and advantages of the present invention will become apparent upon reading the following specification and claims, taken in conjunction with the accompanying drawings.

SUMMARY OF THE INVENTION

According to one aspect of the invention, an air-atomizing fuel burner system is provided including an air compressor, a fuel reservoir and an air-atomizing nozzle. The pressure side of the air compressor is connected to both the air-atomizing nozzle and to the fuel reservoir. The vacuum side of the air compressor is alternately connected to ambient and to the fuel reservoir.

A valve is provided in the suction line of the air compressor for connecting the vacuum side of the air compressor to ambient during the burning cycle, and to the fuel reservoir during the refilling cycle. The valve is operated in response to the fuel level in the fuel reservoir. This is accomplished in accordance with a preferred embodiment by using a solenoidoperated valve. The valve is operated by a mechanically actuated float switch operated by a float in the fuel reservoir.

Air flow restrictors such as flow restriction orifices are provided in the pressure and vacuum lines from the air compressor to the fuel reservoir to control the air pressure and vacuum in the fuel reservoir. Suitable means are optionally provided in the pressure line from the air compressor to regulate the primary air pressure at the air-atomizing nozzle.

The fuel reservoir is connected to a remote fuel supply source. A check valve and filter are provided in the fuel supply line to the fuel reservoir for preventing the flow of fuel back to the fuel supply source, and for filtering the incoming fuel, respectively. The fuel reservoir is also connected to the air-atomizing nozzle. The fuel delivery line contains means for controlling the flow rate of fuel, such as a flow restriction orifice or a variable volume valve. The fuel delivery line is provided with a check valve for preventing the flow of fuel back to the fuel reservoir. The air-atomizing nozzle is of conventional design in which air is used as the means for atomizing fuel to prepare it for combustion.

The over-all operation of the fuel burner system will now be briefly described. During the burning cycle, the suction line of the air compressor is connected to ambient. The air compressor supplies primary air to the air-atomizing nozzle to atomize the fuel into fine particles as it leaves the nozzle opening. Secondary air is supplied to the air-atomizing nozzle in conventional manner, preferably by natural aspiration. The air pressure in the pressure line from the air compressor is controlled by the air pressure regulator. Part of the air pressure in the pressure line from the air compressor is bled off to the fuel reservoir. The air pressure in the fuel reservoir forces fuel from the fuel reservoir to the air-atomizing nozzle. The fuel flow rate to the nozzle is controlled by the air pressure in the fuel reservoir and by the flow restriction means in the fuel delivery line.

After the air-atomizing nozzle has operated for a predetermined period of time and the fuel level has dropped to a predetermined low level, the float in the fuel reservoir operates the float switch causing the solenoid-operated valve to connect the vacuum side of the air compressor to the fuel reservoir. This vacuum draws fuel from the remote fuel supply source through the fuel supply line and refills the fuel reservoir until a predetermined high level is reached. At this point, the float operates the float switch causing the solenoid-operated valve to reconnect the vacuum side of the air compressor to ambient and start the burning cycle.

According to another aspect of the present invention, a flame spreader is employed in combination with an air-atomizing nozzle to stabilize and shape the flame. The position and diameter of the flame spreader are set to provide optimum fuel burning characteristics, and to avoid soot and carbon accumulation on the spreader. In general, it has been found that for optimum burning characteristics for most burner applications, the ratio of the flame spreader diameter to the axial separation distance between the flame spreader and the air-atomizing nozzle should be approximately **1.**

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** represents the primary air and fuel supply system of the present invention; and

FIG. **2** represents the air-atomizing nozzle and flame spreader combination of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. **1,** the first major component of the fuel burner system is air compressor **10.** The air compressor is of conventional design such as a reciprocating diaphragm pressure/vacuum pump and has three separate functions in the over-all system. First, it supplies primary air to air-atomizing nozzle **14** to atomize the fuel. Second, it supplies air pressure to fuel reservoir **12** to deliver fuel to the nozzle. Third, the air compressor acts as a vacuum pump to refill fuel reservoir **12** from a remote fuel supply source **16** when the fuel level in the reservoir reaches a predetermined low level.

The second major component of the fuel burner system is fuel reservoir **12** which is also of conventional design. The fuel reservoir is sized to give a reasonable burning time (e.g., 10 to 15 minutes) at the desired burning rate (e.g., less than 0.5 gph) and to be compatible with the air compressor characteristics such that refill occurs fairly rapidly (e.g., 5 to 10 seconds). During the fuel burning cycle, fuel reservoir **12** is connected to the air pressure side of air compressor **10**, and also to the fuel side of air-atomizing nozzle **14**. During the fuel refilling cycle, reservoir **12** is connected to the vacuum side of air compressor **10**, and also to remote fuel supply source **16**.

The third major component of the fuel burner system is air-atomizing nozzle **14**. Nozzle **14** can be of any conventional design such as the type shown in FIG. 2 in which the primary air does not contact the fuel until it exits from the nozzle orifice, or of the type in which the primary air contacts the fuel prior to its leaving the nozzle. In this latter arrangement, fuel at low pressure (e.g., 1 to 4 psi) is delivered through an inner channel of the nozzle, and primary air at relatively low pressure (e.g., 1 to 15 psi) is delivered through an outer channel. In either case, the air is used to atomize the fuel into fine particles as it leaves the nozzle opening. The air-atomizing nozzle is preferably self-aspirating or, in other words, of the type in which the secondary air is not forced into the combustion zone, but is drawn in naturally by the system.

The pressure side of air compressor **10** is connected to air-atomizing nozzle **14** by air pressure line **18**, and to fuel reservoir **12** by air pressure line **20**. Air pressure regulator **22** is optionally provided to regulate the primary air pressure at air-atomizing nozzle **14**. Air pressure regulator **22** is typically a pressure regulation orifice with its upstream side connected to air pressure line **18** and its downstream side connected to ambient.

The vacuum side of air compressor **10** is alternately connected to ambient and to fuel reservoir **12**. Solenoid-operated valve **24** is provided in suction line **26** for connecting the vacuum side of air compressor **10** to ambient during the burning cycle, and to fuel reservoir **12** during the refilling cycle. Valve **24** is illustrated as a solenoid-operated, two-way valve, but it can take other conventional forms. Valve **24** is connected to suction line **26** by air outlet line **34**. As illustrated, valve **24** is in its normal open position connected to ambient by means of air inlet line **30**. Filter **32** is provided in air inlet line **30** to filter the incoming air. In its normal open position, the solenoid which operates valve **24** is de-energized. Upon energization of the solenoid, valve **24** is moved to its closed position and connects the vacuum side of air compressor **10** to fuel reservoir **12** by closing air inlet **34**. Suction line **26** is shown connected to air pressure line **20**, but can also be connected directly to fuel reservoir **12**.

Air flow restrictor **36**, illustrated as a flow restriction orifice, is provided in air pressure line **20** and acts to restrict the flow of air from air pressure line **18** to fuel reservoir **12**. Generally speaking, air flow restrictor **36** should be as small as possible in order to conserve the primary air flow to nozzle **14**, yet be large enough to supply sufficient air pressure to fuel reservoir **12** to deliver fuel to nozzle **14** at the desired pressure and flow rate.

Air flow restrictor **38**, also illustrated as a flow restriction orifice, is provided in suction line **26** and acts to restrict the flow of air from fuel reservoir **12** to air compressor **10**. Generally speaking, air flow restrictor **38** should be as large as possible so that the refilling time for fuel reservoir **12** is relatively short (e.g., 5 to 10 seconds), yet be small enough to allow sufficient air pressure to be supplied to fuel reservoir **12** to deliver fuel to nozzle **14** at the desired pressure and flow rate.

Fuel reservoir **12** is connected to remote fuel supply source **16** by fuel supply line **40**. Fuel supply source **16** can be an underground or above ground fuel storage tank, for example. Check valve **42** is provided in fuel supply line **40**. Check valve **42** only permits the flow of fuel from fuel supply source **16** to fuel reservoir **12**, and prevents the return of fuel from fuel reservoir **12**. Fuel filter **44** is provided in fuel supply line **40** for filtering the incoming fuel. The fuel is any liquid fuel conventionally used in air-atomizing fuel burners such as fuel oil and particularly No. **1** and No. **2** grade fuel oil.

Fuel reservoir **12** is connected to air-atomizing nozzle **14** by fuel delivery line **46**. Fuel delivery line **46** contains fuel flow restrictor **48**. Flow restrictor **48** can be of any conventional design, such as a flow restriction orifice or a variable volume valve. Flow restrictor **48** is sized to provide the desired fuel pressure and flow rate to nozzle **14** at the primary air pressure selected. Fuel delivery line **46** contains check valve **50** which allows fuel to flow from fuel reservoir **12** to air-atomizing nozzle **14**, but prevents the return of fuel to the fuel reservoir.

Solenoid-operated valve **24** is pilot operated to connect the vacuum side of air compressor **10** to ambient during the burning cycle, and to fuel reservoir **12** during the refilling cycle. Solenoid-operated valve **24** is controlled by float **52** and float switch **54**. The weight and buoyancy of float **52** are selected to match the characteristics of float switch **54** such that there is a significant variation in fuel level between switch activations. This variation is represented in FIG. **1** as fuel "high" level **56** and fuel "low" level **58**. Float switch **54** is of the type, such as a snap action switch, which will be closed by float **52** when the fuel is at "low" level **58**, but will not be opened by float **52** until the fuel has reached "high" level **56**. The solenoid of valve **24** is energized by the closing of float switch **54** and the vacuum side of air compressor **10** connected to fuel reservoir **12**.

The solenoid-operated valve, float switch and float assembly illustrated in FIG. **1** represent only one of several means which can be used to alternately connect air compressor **10** to ambient and to fuel reservoir **12**. For example, a valve directly operated by a float could be used to accomplish the same result.

The over-all operation of the fuel burner system will now be described. During the burning cycle, suction line **26** of air compressor **10** is connected to ambient. Air compressor **10** supplies primary air through air pressure line **18** to air-atomizing nozzle **14**. The pressure in air pressure line **18** is regulated by pressure regulator 22. Part of the air pressure in air pressure line 18 is bled off through air pressure line 20 to fuel reservoir 12. The pressure in fuel reservoir 12 is controlled, for a given primary air pressure, by the diameter ratio of flow restriction orifice 38 to flow restriction orifice 36. At the start of the burning cycle, the fuel level in fuel reservoir 12 is at "high" level 56, float 52 is at its uppermost position, float switch 54 is open, and the solenoid-operated valve 24 is connecting the vacuum side of air compressor 10 to ambient. The air pressure in fuel reservoir 12 forces the fuel through delivery line 46 to air-atomizing nozzle 14, and the fuel flow rate is regulated by fuel flow restrictor 48. At nozzle 14, fuel from delivery line 46 is atomized into fine particles by the primary air from air pressure line 18 and is ignited and burned in the presence of secondary air in conventional manner.

As the fuel is burned at air-atomizing nozzle 14, the fuel level in fuel reservoir 12 gradually drops to "low" level 58. At this level, float 52 closes float switch 54 which energizes the solenoid of valve 24 and connects the vacuum side of air compressor 10 to fuel reservoir 12. The vacuum in fuel reservoir 12 is controlled, for a given air compressor vacuum pressure, by the diameter ratio of flow restriction orifice 38 to flow restriction orifice 36. During the refilling cycle, fuel is drawn into fuel reservoir 12 through fuel supply line 40 from fuel supply source 16 and is simultaneously filtered by filter 44. Once the fuel in fuel reservoir 12 has reached "high" level 56, float 52 opens float switch 54 which de-energizes the solenoid of valve 24 and reconnects the vacuum side of air compressor 10 to ambient, thus reestablishing the burning cycle.

The present air-atomizing fuel burner system is particularly useful for applications requiring less than about 0.5 gallons per hour (hereinafter gph) burning rates such as for hot water heaters. By way of illustration, burning rates in the range of 0.2 to 0.45 gph can conveniently be provided using the present burner system at primary air pressures between about 8 and 18 psig. The air pressure in fuel reservoir 12 is regulated by proper selection of the sizes of air flow restrictors 36 and 38. For example, the air pressure in fuel reservoir 12 can be limited to a maximum of about 1.5 psig at the maximum design air pressure of 18 psig by using a diameter ratio of flow restriction orifice 38 to flow restriction orifice 36 of about 1.75. Increasing this flow restriction orifice diameter ratio will lead to lower air pressures in fuel reservoir 12. For a fixed air flow restriction orifice diameter ratio, the fuel flow rate to air-atomizing nozzle 14 will decrease with decreasing primary air pressure. Accordingly, the primary air pressure can be used to regulate the fuel burning rate within the system's design limits.

Turning now to another aspect of the present invention, FIG. 2 illustrates the air-atomizing nozzle and flame spreader combination of the present invention. The air-atomizing nozzle and flame spreader combination of FIG. 2 is ideally suited for use in the over-all air-atomizing fuel burner system of FIG. 1 and, accordingly, will be described as part of this system. It should be understood, however, that the air-atomizing nozzle and flame spreader combination in accordance with this aspect of the invention can be used with other primary air and fuel supply systems. Air-atomizing nozzle 14 is of conventional design and comprises a nozzle head 60 having an air aperture 62. Surrounding nozzle head 60 is fuel container 64 which is open to the atmosphere and allows fuel to be sprayed from air-atomizing nozzle 14. Fuel container 64 is supplied by fuel from fuel delivery line 46. The fuel level in fuel container 64 is kept sufficiently high to form a thin film of fuel over nozzle head 60 and air aperture 62 during the burning cycle. Air under pressure is supplied to nozzle head 60 through air pressure line 18. It is generally desirable in accordance with this aspect of the present invention that the air-atomizing nozzle 14 have a relatively narrow spray angle (e.g., about 30°).

Flame spreader 66 is of the conventional shape found in gas-burner applications, and can be formed from any conventional material such as stainless steel or ceramics. Flame spreader 66 is generally disc-shaped and typically has a flat, planar or convex flame engaging surface. The exact shape and materials of construction of the flame spreader 66, however, do not form part of the present invention. The flame spreader has been found to be particularly useful in fuel burner systems employing low fuel burning rates in the range between 0 and 0.5 gph.

Flame spreader 66 may be supported relative to air-atomizing nozzle 14 in conventional manner. As illustrated in FIG. 2, air-atomizing nozzle 14 is supported by burner base 68. Attached to burner base 68 are upright flame conduit support legs 70 which in turn are attached to flame conduit support ring 72. Flame conduit 74 is supported by support legs 70 and support ring 72. Flame spreader 66 is held in position by flame spreader support legs 76 which are attached to flame conduit 74. Ignitor 78 is attached to burner base 68 and is of conventional design, such as a high voltage spark ignitor.

During operation, primary air atomizes the fuel into fine particles as it expands through air aperture 62 of nozzle head 60. These fine particles are mixed with secondary air which is drawn into the system between flame conduit support legs 70 by natural aspiration. The atomized fuel is ignited by ignitor 78 and the resulting flame directed to flame spreader 66 by flame conduit 74. At flame spreader 66, the flame is stabilized and shaped, the upper surface of flame conduit 74 acting as a radiation shield.

Flame spreader 66 should be positioned perpendicular to air-atomizing nozzle 14 and approximately centered (i.e., within about 0.25 inch) on the nozzle. For optimum combustion, flame spreader 66 should be in the gaseous or hydroxyl type combustion zone. This zone is downstream from the drop vaporization zone and upstream from the yellow flame or carbonaceous combustion zone. If flame spreader 66 is too far into the drop vaporization zone, deposits from liqiud vaporization and cracking will form on its surface. On the other hand, if flame spreader 66 is too large or too far into the yellow flame or carbonaceous zone, carbon will collect on its surface.

Since increasing the fuel spray rate increases the flame length, flame spreader 66 should be moved further away from air-atomizing nozzle 14 as the fuel spray rate is increased. By way of illustration, adequate combustion has been found to occur when the axial separation distance (X) between nozzle head 60 and flame spreader 66 is between about 1.5 and 5 inches for low burning rates of between about .05 and 0.5 gph. For optimum burning characteristics for most burner applications, it has been found best to use a ratio of flame speader diameter (D) to axial separation distance (X) of about **1.** The ignitor **78** location is not critical, however, it should be on the fringe of the spray and about 0.75 to 1.5 inches downstream from the air-atomizing nozzle for most applications.

To illustrate the present invention, the air-atomizing fuel burner system of FIG. **1** was employed in combination with the flame spreader and air-atomizing nozzle combination of FIG. **2.** The flame spreader diameter (D) and axial separation distance (X) between air-atomizing nozzle head **62** and flame spreader **66** were each 3.5 inches. Flame spreader **66** was ceramic, and of conventional disc-shaped design with a flat, planar flame engaging surface. It was positioned parallel to air-atomizing nozzle **14** with its center within 0.25 inch of the center of spray of air-atomizing nozzle **14.** Air-atomizing nozzle **14** had an aperture size **62** of 0.018 inch diameter. The air pressure in pressure line **18** from air compressor **10** was **15** psig during the burning cycle, and 1 psig during the reservoir refilling cycle. Air flow restriction orifice **36** had a 0.020 inch diameter, and flow restriction orifice **38** a 0.030 inch diameter. The pressure in vacuum line **26** during the burning cycle was **0** psig, and −10 psig during the reservoir refilling cycle. The air pressure in air pressure line **20** was 1.5 psig during the burning cycle, and −10 psig during the reservoir refilling cycle. The pressure in fuel reservoir **12** during the burning cycle was 1.5 psig which provided fuel delivery to line **46** to air-atomizing nozzle **14.** The fuel burning rate was 0.36 gph. The unit ran satisfactorily for 420 hours with burning cycles of 10 minutes on and 10 seconds off, which were automatically maintained by float **52,** float switch **54** and solenoid-operated valve **24.**

The invention in its broader aspects is not limited to the specific details shown and described, and departures may be made from such details without departing from the principles of the invention and without sacrificing its chief advantages.

What is claimed is:

1. An air-atomizing fuel burner system comprising air-atomizing nozzle means for using air under pressure to atomize liquid fuel, air compressor means, means for delivering air under pressure from said air compressor means to said air-atomizing nozzle means, fuel reservoir means for storing liquid fuel, means for supplying liquid fuel to said fuel reservoir means from a remote fuel supply source, means for delivering liquid fuel from said fuel reservoir means to said air-atomizing nozzle means, means for delivering a portion of said air under pressure from said air compressor means to said fuel reservoir means, and means for connecting the vacuum side of said air compressor means to ambient during the burning cycle of said air-atomizing nozzle means and to said fuel reservoir during the reservoir refilling cycle.

2. The air-atomizing fuel burner system of claim **1** in which said means for delivering a portion of the air under pressure from said air compressor means to said fuel reservoir means includes air flow restriction means for restricting the flow of air to said fuel reservoir means.

3. The air-atomizing fuel burner system of claim **1** in which said means for delivering liquid fuel to said air-atomizing nozzle means from said fuel reservoir means includes fuel flow restriction means for restricting the flow of fuel to said air-atomizing nozzle means.

4. The air-atomizing fuel burner system of claim **3** in which said means for restricting the flow of fuel to said air-atomizing nozzle means is a flow restriction orifice.

5. The air-atomizing fuel burner system of claim **1** in which said means for connecting the vacuum side of said air compressor means to said fuel reservoir means includes means for restricting the flow of air from said fuel reservoir means.

6. The air-atomizing fuel burner system of claim **1** in which said means for connecting the vacuum side of said air compressor means to said fuel reservoir means includes means responsive to the fuel level in said fuel reservoir and a valve pilot operated by said responsive means.

7. The air-atomizing fuel burner system of claim **6** in which said means responsive to the fuel level in said fuel reservoir is a float and mechanically actuated switch combination.

8. The air-atomizing fuel burner system of claim **1** in which said means for supplying air under pressure to said air-atomizing nozzle means from said air compressor means includes means for regulating the air pressure supplied to said air-atomizing nozzle means.

9. An air-atomizing fuel burner system comprising air-atomizing nozzle means for using air under pressure to atomize liquid fuel, air compressor means, means for delivering air under pressure from said air compressor means to said air-atomizing nozzle means, fuel reservoir means for storing liquid fuel, means for supplying liquid fuel to said fuel reservoir means from a remote fuel supply source, means for delivering liquid fuel from said fuel reservoir means to said air-atomizing nozzle means, means for delivering a portion of said air under pressure from said air compressor means to said fuel reservoir means, and means for connecting the vacuum side of said air compressor means to ambient during the burning cycle of said air-atomizing nozzle means and to said fuel reservoir during the reservoir refilling cycle, means for igniting the atomized liquid fuel in the presence of combustion air to produce a combustion flame, and flame spreader means located downstream of said ignition means for stabilizing and shaping said flame.

10. The air-atomizing fuel burner system of claim **9** in which the ratio of flame spreader diameter to separation distance between said flame spreader and air-atomizing nozzle means is about 1.

11. The air atomizing fuel burner system of claim **9** in which said flame spreader is located in the gaseous or hydroxyl type combustion zone of said combustion flame.

12. The air-atomizing fuel burner system of claim **9** in which said flame spreader is between about 1.5 and 5 inches downstream from said air-atomizing nozzle.

13. An air-atomizing fuel burner system comprising air-atomizing nozzle means for using primary air under pressure to atomize liquid fuel, means for delivering liquid fuel to said air-atomizing nozzle means, means for delivering primary air under pressure to said air-atomizing nozzle means to atomize said liquid fuel, means for igniting the atomized liquid fuel in the presence of secondary air to produce a combustion flame, and flame spreader means located downstream of said air-atomizing nozzle means for stabilizing and shaping said flame, said flame spreader means being located in the gaseous or hydroxyl type combustion zone of said combustion flame.

14. The air-atomizing fuel burner system of claim **13** in which the ratio of flame spreader diameter to separation distance between said flame spreader and air-atomizing nozzle means is about 1.

15. The air-atomizing fuel burner system of claim **13** in which said flame spreader is between about 1.5 and 5 inches downstream from said air-atomizing nozzle.

16. A low pressure air-atomizing fuel burner system comprising air-atomizing nozzle means for using primary air to atomize liquid fuel, means for delivering liquid fuel under low pressure to said air-atomizing nozzle means, means for delivering primary air to said air-atomizing nozzle means to atomize said liquid fuel, means for igniting the atomized liquid fuel in the presence of secondary air to produce a combustion flame, and flame spreader means located downstream of said air-atomizing nozzle means for stabilizing and shaping said flame, said flame spreader means being located in the gaseous or hydroxyl type combustion zone of said combustion flame.

17. The air-atomizing fuel burner system of claim **16** in which said primary air and said liquid fuel are each delivered to said air-atomizing nozzle means at a pressure of about **1** to **15** psi.

18. The air atomizing fuel burner system of claim **16** in which said liquid fuel is delivered to said air atomizing nozzle means at a pressure of about 1 to 4 psi.

19. An air-atomizing fuel burner system comprising air-atomizing nozzle means for using primary air under pressure to atomize liquid fuel, air compressor means, means for delivering primary air under pressure from said air compressor means to said air-atomizing nozzle means, fuel reservoir means for storing liquid fuel, means for delivering liquid fuel from said fuel reservoir means to said air-atomizing nozzle means, means for delivering a portion of said air under pressure from said air compressor means to said fuel reservoir means, means for igniting the atomized liquid fuel in the presence of secondary air to produce a combustion flame, and flame spreader means located downstream of said air-atomizing nozzle means for stabilizing and shaping said flame, said flame spreader means being located in the gaseous or hydroxyl type combustion zone of said combustion flame.

20. The air-atomizing fuel burner system of claim **19** in which the ratio of flame spreader diameter to separation distance between said flame spreader and air-atomizing nozzle means is about **1.**

21. The air-atomizing fuel burner system of claim **19** in which said flame spreader is between about 1.5 and 5 inches downstream from said air-atomizing nozzle means.

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