

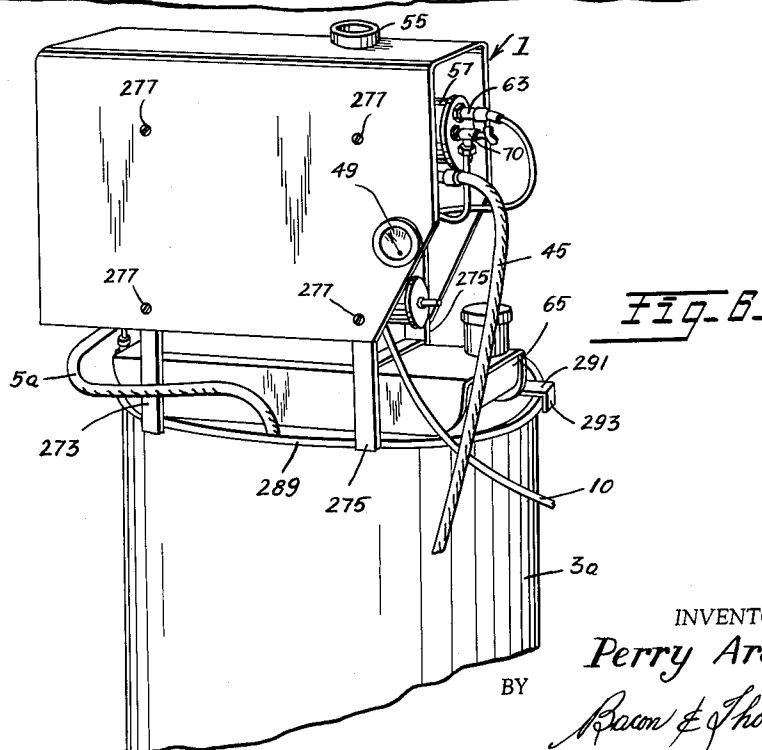
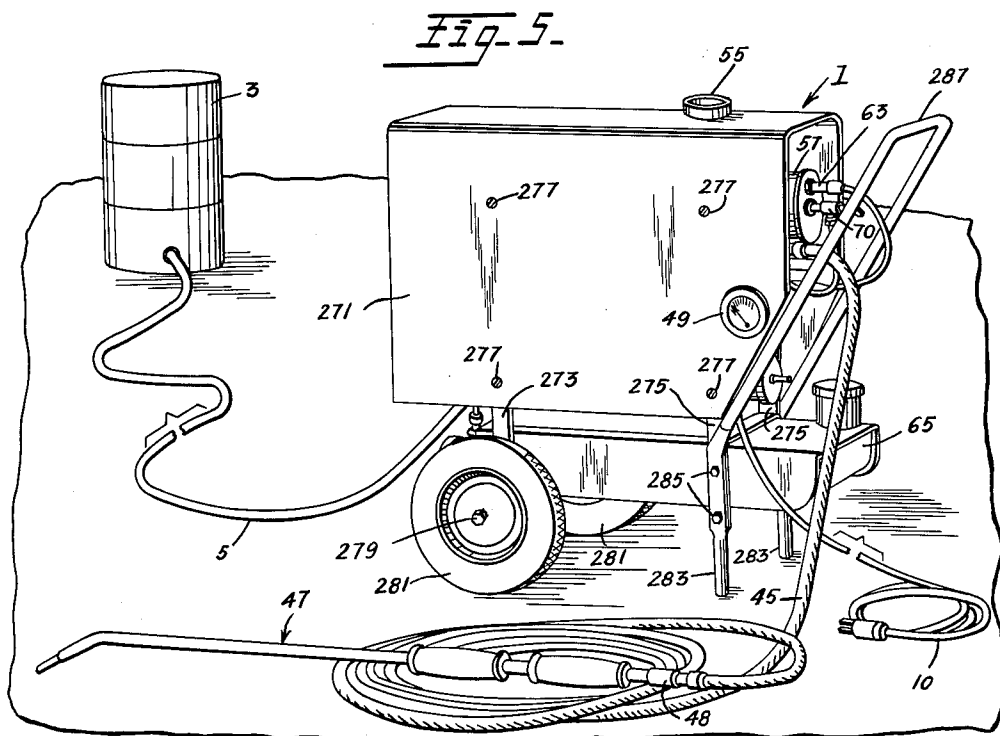
July 19, 1966

P. ARANT
INTERLOCKED WATER AND FUEL SYSTEM
FOR STEAM CLEANERS AND THE LIKE

3,261,330

Filed Nov. 7, 1962

3 Sheets-Sheet 3



INVENTOR.

Perry Arant

BY

Racm & Thomas

ATTORNEYS

1

3,261,330

INTERLOCKED WATER AND FUEL SYSTEM FOR STEAM CLEANERS AND THE LIKE

Perry Arant, San Gabriel, Calif., assignor to Clayton Manufacturing Company, El Monte, Los Angeles, Calif., a corporation of California

Filed Nov. 7, 1962, Ser. No. 236,014

17 Claims. (Cl. 122-448)

The present invention relates to a simplified and compact unit that is basically designed to be used as a liquid heater, steam generator, or a steam cleaner.

One of the principal features of the present unit is that it embodies a construction wherein the supply system of water, cleaning solution, etc., to the heating coil is so interlocked with the supply system of liquid fuel to a burner to heat the coil, that the supply of fuel is automatically cut-off, if the supply of water, or other liquid to the pump that feeds the heating coil, fails.

While the invention has been described as relating to a unit that can be used as either a liquid heater, steam generator, or a steam cleaner, the unit will be described hereinafter by way of example, and not limitation, in connection with its use as a steam cleaner. The expression "steam cleaner," as used herein, means a cleaner unit wherein a solution of water and a cleaning compound are heated under pressure while flowing through a coil so that the solution partially vaporizes when discharged into the atmosphere. Such units are not new, per se. However, prior units are bulky, heavy, highly complicated and expensive. Consequently, there has been a long standing need for a small steam cleaner unit that is suitable for use in small machine shops, garages, brake and front end specialty shops, auto body painting and repair shops, gasoline service stations, hotels, institutions, etc.

The unit of the present invention meets this need in that it is much smaller than any steam cleaner unit heretofore produced; is much lower in initial cost than any prior steam cleaner unit; requires a minimum of maintenance; is easy to start and to operate; and is economical in that it will run for long periods of time on a very small amount of fuel. The present unit can be used at any place where it is desired to effect a steam cleaning operation, and is designed so that it can be sold as a stationary unit, or be mounted upon wheels at one end of the unit and support legs and a guide handle at the other end, to render it portable and easily movable manually to any location convenient to the object or area to be cleaned.

Another important feature of the present steam cleaner unit is its light weight, which renders it readily mobile. The shipping weight of the stationary model will be only about 100 pounds; whereas, the shipping weight of the portable model will be only about 110 pounds.

A further feature is that the steam cleaner unit can be operated by burning kerosene, gasoline (where code requirements permit) or mineral spirits with a 100-degree maximum flash-point.

The interlocking of the solution supply and fuel supply systems constitutes an extremely important safety feature of the present steam cleaner unit and is effected by the design of a novel multiple chamber pump, which includes a diaphragm arranged so that the pulses imparted to the diaphragm through a prime mover to effect pumping of the solution into the heating coil are also used to effect pumping of the fuel to the burner. Actually, the impulses produced in the solution being pumped are transmitted by said solution to a membrane, or second diaphragm, which pumps the fuel to the burner.

Accordingly, the principal object of the invention is to provide a simplified, compact, economical, lightweight, and relatively inexpensive unit that can be used as a steam cleaner, a water heater, or a steam generator.

2

An important object is to provide a unit of the foregoing type that provides a maximum of safety by assuring that the supply of fuel will be promptly cut off upon failure of the supply of liquid to the pump, which pumps it into the heating coil.

A more specific object is to provide a multiple chambered pump actuated by a single prime mover for simultaneously effecting pumping of liquid to the heating coil and fuel to the burner.

A further object is to provide a combined back-pressure regulator and snubber that will insure sufficient pressure in the solution chamber of the pump to effect impulse pumping of fuel in an adjoining chamber.

A still further object is to provide means for use with a pump of the character described, which can be adjusted to vary the fuel pressure to suit the burner requirements of the heater.

Another object is to provide a steam cleaner that can be operated at full capacity cleaning with an extremely low rate of fuel consumption.

Another object is to provide a steam cleaner that is ready for use in service within a very few minutes after the burner has been started.

Other objects and features of the invention will be readily apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a diagrammatic view of the principal components of the present steam cleaner system, with the heating coil and its housing shown in cross-section;

FIG. 2 is an enlarged, fragmentary, vertical, sectional view through a combined back-pressure regulator and snubber, or pulse absorber;

FIG. 3 is an enlarged fragmentary, vertical, sectional view through the multiple chamber pump for simultaneously pumping liquid into the heating coil and liquid fuel to the burner;

FIG. 4 is an enlarged, fragmentary, transverse sectional view through the working chambers of the multiple pump and the fuel pressure control means, taken on line 4-4 of FIG. 3;

FIG. 5 is a perspective of the components of FIG. 1, assembled with an enclosing hood to provide a portable steam cleaner unit; and

FIG. 6 is a side view of a stationary form of steam cleaner unit.

Referring to FIG. 1, the present steam cleaner unit is generally identified by the numeral 1 and includes a storage tank 3 containing a supply of cleaning solution, such as water and a suitable cleaning compound. The tank 3 is connected by a section of hose 5 with one chamber of a multiple chamber pump, generally identified by the numeral 7. The hose 5 of a portable unit is about twenty-five feet long. The pump 7 is driven by a prime mover 9, preferably in the form of an electric motor. Electric current is supplied to the motor 9 through a cord 10. The motor 9 has a shaft 11 upon which a pulley 13 is mounted. A belt 15 extends around the pulley 13 and drives a pulley 17 mounted upon a shaft 19 carried by a bracket 21. The shaft 19 carries an eccentric 23 that drives a rod 25 connected with the pump 7 in a manner described hereinafter.

The solution discharged from the pump 7 flows through a conduit 27 to the inlet side of a combined back-pressure regulator and snubber (pulse absorber), generally identified by the numeral 29. Solution discharged from the snubber 29 flows through a conduit 31 to the inlet end 33 of a heating coil 35. The heating coil 35 is a component of a liquid heater assembly generally identified by the numeral 37. The heating coil 35 has a number of outer convolutions 39 connected to a number of similar but smaller inner convolutions 41, to provide a single tube, two-pass formation. The inner convolutions terminate in

3

a discharge pipe 43 to which one end of a twenty-foot-long solution discharge hose 45 is connected. A cleaning gun 47, having a restrictor 48 mounted therein, is connected with the other end of the hose 45. A pressure gage 49 is connected with the discharge pipe 43 in advance of the hose 45.

The heating coil 35 is disposed in a horizontal, cylindrical casing 53, suitably jacketed against thermal losses by heat insulating material, not shown. A stack 55, for the exhaust of products of combustion, is mounted on the upper portion of the casing 53. One end of the casing 53 is closed by a solid end wall 56, and a burner housing 57 is mounted in the other end wall 59 and projects a substantial distance into the inner convolutions 41 of the heating coil 35. A pressure-atomizing fuel nozzle 61 is mounted in the burner housing 57 adjacent a pair of electrodes of a spark plug 63, which supply a continuous spark, when the unit is in operation, for igniting the fuel discharged from the nozzle 61. Air for combustion is supplied under forced-draft from a blower, not shown, to the burner 57 through a duct 64.

Liquid fuel is stored in a closed fuel tank 65, from which it is withdrawn through conduit 67 by the pump 7 and delivered under pressure to the burner nozzle 61 through a conduit 69 having a fuel shut-off valve 70 connected therein. A fuel pressure control assembly, generally identified by the numeral 71 is mounted upon the pump 7 for a purpose that will be described hereinafter.

The structural details of the pump 7, and of the adjustable fuel pressure control 71 are best shown in FIGS. 3 and 4. As is shown in FIG. 3, the pump 7 comprises housing sections 73 and 75 separated by a flexible diaphragm or membrane 77 that forms a flexible wall between a solution-pumping chamber 79 in the housing section 73, and a fuel-pumping chamber 81 in the housing section 75. The housing section 73 is in the form of a shallow, circular, cup having an opening 83 in the wall 85 thereof. A flexible pumping-diaphragm 87 is positioned over the chamber 79 between the edge of the cup-shaped section 73 and a clamping ring 89 to produce pulses in said chamber. The rod 25 has a circular enlargement 91 that engages one side of the diaphragm 87. A threaded extension 93 of the rod 25 extends through a central opening in the diaphragm 87 and has a diaphragm-supporting washer 95 and a clamping nut 97 mounted thereon.

The outer wall of the fuel-pumping chamber 81 is formed by a flexible, fuel-pressure control diaphragm 99, which is disposed between the fuel-pumping housing section 75 and the fuel pressure control device 71. The device 71 includes a rectangular-shaped frame portion 101 having a base 103 provided with an opening 105. A first washer 107 is positioned between the diaphragm 99 and the base 103, and a second washer 109 is positioned on the other side of the base 103.

The housing section 75, the membrane 77, the housing section 73, the diaphragm 87 and the ring 89 are held in assembled relation by threaded bolts 111, which pass through aligned openings formed in said housing section 75, membrane 77, housing section 73 and diaphragm 87, and into threaded openings 112 in the ring 89. The fuel pressure adjusting assembly 71 is secured to the outer side of the housing section 75 by bolts 113 passing through aligned openings in the washer 109, base 103, washer 107 and diaphragm 99, and into suitable threaded openings 110 in the housing section 75.

The amount of fuel pressure that is required to flex the diaphragm 99 is controlled by a compression spring 115 having one end seated in a dished washer 117 engaged with the outer side of the diaphragm 99. A disc 119 supports the other end of the spring 115 to retain it in position. A rectangular plate 123 is engaged with the frame 101 and has a threaded central opening 125 to receive a screw 127, which has a conical end that bears against the disc 119. The screw 127 is adjustably mounted in the

4

threaded opening 125 in the plate 123. A handle 131 is carried by the adjusting screw 127 for manual adjustment of said screw, and a lock nut 133 is mounted on the screw for jamming against the frame 101 to hold the screw in adjusted position.

The housing section 75 has an inlet for admitting liquid fuel into the fuel pumping chamber 81. This inlet passage comprises a bore 135, a counterbore 137 and a larger threaded counterbore 139. A connector 141 is threaded into the counterbore 139 and carries a fitting 140, which connects the fuel supply conduit 67 with the inlet of the fuel pumping chamber 81. The connector 141 forms a housing for an inlet ball check valve 143, which is disposed between a seat 145 in said connector and a spring 147 received in the counterbore 137. The spring 147 normally tends to maintain the inlet check valve 143 closed.

The fuel pumping section 75 has an outlet passage for liquid fuel that extends from the chamber 81 to the outer periphery of the housing section 75 and includes a bore 149 and a counterbore 151, which is threaded at its outer end. A connector 153 is mounted in the counterbore 151 and is recessed to receive a compression spring 155. One end of the spring 155 engages an outlet ball check valve 157, which cooperates with a valve seat 159 seated upon the lower end of the counterbore 151. A conventional fitting 161 connects the fuel discharge conduit 69 with the connector 153.

Referring to FIG. 4, the solution-pumping housing section 73 has an opening 163 communicating with the chamber 79. One end of a pipe nipple 165 is threaded into the opening 163 and its other end is threaded into an opening 167 in a coupling 169. One end of the solution supply hose 5 is connected with the coupling 169 by an inlet check valve assembly including a tubular connector 171 having a shoulder 173 located approximately midway of its length. The lower end 175 of the connector 171 extends into the hose 5 and is secured thereto by a clamp 177, while the upper end 179 of said connector is threaded into the lower end of the coupling 169. The flow of solution into the coupling 169 is controlled by a one-way, disc-type check valve 181 which engages a valve seat 183 secured in place by threads 185 located about midway of the connector 171. The upper end of the connector 171 is internally threaded to receive a bushing 187 having an annular skirt 193 depending therefrom. The lower edge of the skirt is slotted inwardly thereof as indicated at 195 and forms an abutment for the upper side of the check valve disc 181. The slots 195 permit flow past the disc 181 when said disc is in its fully open position. A spring 197 is received within the bushing 187 and engages the disc 181 and normally tends to retain it on the seat 183.

An outlet check valve assembly includes a tubular connector 196 that is threaded into the upper end of the coupling 169. A valve seat 198 is threaded into the inner end of the connector 196. The solution discharge conduit 27 is connected by a fitting 200 with the bushing 196 by a connector 199. The connector 199 has a bore 201 and a depending skirt containing a counterbore 203 and having notches 205 in its lower edge. The flow of solution from the interior of the coupling 169 is controlled by a disc-type, outlet check valve 207, which engages the valve seat 198. The disc 207 is continuously urged toward the seat 198 by a compression spring 209, one end of which engages the bottom of the counterbore 203 and the other end of which engages the disc 207. When the disc 207 is in its full open position, it will engage the lower end of the skirt, but solution flow past said disc can occur through the notches 205.

The coupling 169 contains a chamber 211, which communicates with the solution-pumping chamber 79, and is disposed between the inlet check valve 181 and the outlet check valve 207. It will be understood that, as the solution-pumping diaphragm 87 is flexed back and forth by the rod 25, solution will be drawn through the hose 5 from the tank 3 past the inlet check valve 181

5

on the suction stroke of the diaphragm 87 and discharged past the outlet check valve 207 on the work or pressure stroke. In other words, as the diaphragm 87 is flexed toward the left, as viewed in FIG. 3, the solution to be pumped is sucked past the inlet check valve 181 into the chamber 79, and upon the work stroke of the diaphragm 87, the solution drawn into the chamber 79 has an impulse imparted thereto, which results in a portion of the solution being displaced from said chamber through the pipe nipple 165, past the outlet check valve 207 and into the conduit 27 for delivery to the heating coil 35.

The solution discharged into the conduit 27 is delivered to the combined back-pressure regulator and snubber 29, which is illustrated in cross-section in FIG. 2. The snubber 29 comprises a housing 213 having a threaded inlet opening 215 to receive a fitting 217, to which one end of the conduit 27 is connected. The inlet opening 215 intersects a vertical passage 219, which is threaded at its lower end 221 to receive a drain cock 223, and communicates at its upper end with a shallow annular recess 225 formed in the upper face 226 of the housing 213. The housing 213 has an angle-shaped outlet passage 227, which is threaded at its outer end 229 to receive a conventional fitting 231 which is connected to one end of the conduit 31. The inner end of the passage 227 terminates in an opening 233 at the center of the annular recess 225. A vertical passage 235 intersects the passage 227 and is threaded at its outer end to receive an adjustable pressure relief valve 237.

A flexible diaphragm 239 overlies the face 226 of the housing 213, and incidentally overlies the annular recess 225 and engages a rounded seat 241 surrounding the opening 233. An inverted cup-shaped casing 243 is positioned over the diaphragm 239, and a plurality of screws 245 extend through a marginal flange 247 of the casing 243, through openings in the diaphragm 239 and into threaded openings 249 in the housing 213. The diaphragm 239 is biased into contact with the seat 241 by a compression spring 251. One end of the spring 251 bears against a dished washer 253 engaged with the central portion of the diaphragm 239, while the other end of the spring is seated in an upper, dished washer 255. The washer 255 is retained in a central position relative to the casing 243 by an upwardly extending boss 257 formed thereon and projecting into an opening 259 formed in the bottom wall of the cup-shaped casing 243. The compression spring 251 is calibrated to provide the required pressure in the solution pumping chamber for the proper operation of the apparatus.

It will be understood that each pumping impulse imparted to the solution discharged from the pumping chamber 79 into the conduit 27 is also imparted to the snubber diaphragm 239 by the solution in the annular recess 225, causing said diaphragm to be flexed away from the seat 241 to permit the flow of solution through the inlet opening 215, into passage 219 and the annular recess 225 for discharge through the opening 233, outlet passage 227 and conduit 31 to be delivered to the inlet end 33 of the heating coil 35. When the unit 1 is being used as a steam cleaner, the water will contain a cleaning compound in solution, which will be heated as it is pumped through the heating coil 35, and delivered in a heated condition through the hose 45 to the cleaning gun 47.

The snubber diaphragm 239 and the spring 251 function as a shock absorbing means for absorbing the pump pulsations and delivering solution to the heating coil in a smooth-flowing, continuous stream. The back-pressure regulator and snubber 29 also serves the additional function of assuring that a back pressure exists on the solution pump chamber 79 to provide the impulses necessary to effect pumping of the fuel in the chamber 81. Thus, in order to produce pressure in the fuel line 69 during a cold start, the snubber device 29 will create sufficient back

6

pressure on the solution system to cause the pumping impulses to raise the fuel pressure to the desired range.

As has been previously explained, the pump 7 receives its solution supply from the tank 3 through hose 5 and delivers it through conduits 27 and 31 to the inlet end 33 of the heating coil 35. As the solution is progressively heated by the burner 57 and delivered through the restrictor 48 to the cleaning gun 47, the solution pressure will rise to a range of about 60 to 90 pounds per square inch (the preferred working pressure being about 70 to 75 pounds per square inch), depending upon the rate of fuel supply. This pressure will be indicated on the gage 49 and will produce a pressure rise in the conduit 31, which raises the pressure in the outlet passage 227 of the snubber device 29. This pressure is effective upon the diaphragm 239 which has its lower side exposed thereto, so that the spring 251 is further compressed and thereby automatically reduces the pressure drop between the snubber inlet opening 215 and the outlet opening 227. The snubber device 29 may be equipped with a preset spring 251 to suit the required liquid pressure impulse on the fuel pump so that it will reach the required fuel pressure for the burner 57. It is inherent that the fuel pressure will range about 10% higher than the solution pressure, due to the dynamics in the reciprocating solution pump. For example, if the combined back-pressure regulator and snubber 29 is set for about 50 lbs. per square inch solution pressure, the fuel pump will deliver fuel at a pressure of about 55 lbs. per square inch.

It will be readily understood from FIG. 3 that, as the rod 25 is reciprocating to produce pumping impulses in the solution-pumping chamber 79, such impulses will be directly transmitted through the membrane 77 to the fuel-pumping chamber 81. The impulses transmitted through the membrane 77 are in turn transmitted through the liquid fuel in the chamber 81 to the diaphragm 99, so that as the diaphragm 77 is flexed toward the right, it produces a flexing movement of the diaphragm 99, causing fuel to be discharged from the chamber 81 into the conduit 69. Upon the suction stroke of the pumping diaphragm 87, the membrane 77 will be relieved of the pulse pressure and will return toward the left and the inlet ball check valve 145 will open and permit fuel to be drawn into the fuel-pumping chamber 81. It will be apparent that, if no solution is available in chamber 79, it will be impossible to transmit a pumping impulse to the membrane 77 to pump fuel to the burner. Hence, in the event of failure of the solution supply, the supply of fuel to the burner will be automatically cut off, effecting a safe shut-down of the unit. This feature eliminates the need for a thermally-responsive water-failure safety control, and thus contributes to the elimination of the cost of such control.

It will also be apparent that, pumping impulses imparted to the fuel in the fuel-pumping chamber 81 by the membrane 77 will be transmitted to the diaphragm 99 of the fuel-pressure regulating and control means 71. The diaphragm 99 will flex under such impulse to the extent permitted by the spring 115.

The compression rate of the spring 115 controls the flexing or displacement of the diaphragm 99, and such displacement can be varied by adjusting the screw 127 to hold the fuel pressure to the desired burner requirement.

It is pointed out that the extent of flexing of the membrane 77 is limited by the engagement thereof with a wall 261 in the housing section 75 having a central opening 263 surrounded by a seat 265. A space adjacent the seat 265 forms a chamber 267 from which fuel is forced through the opening 263 upon the work stroke of the membrane 77. A port 269 in the wall 261 permits the escape of air trapped in the chamber 267 into the chamber 81.

The unit 1 can be placed in operation by starting the electric motor 9 to drive the pump 7 to fill the heating

7

coil 25 until solution starts to flow out of the gun 47. The fuel valve 70 is then opened. This sequence avoids any possible overheating of the coil 35. It will be understood that the spark plug 63 is connected in circuit with the motor 9 so that a spark occurs simultaneously with the starting of the motor and continues throughout the operation of the unit. The pump 7 will then deliver solution to the heating coil 35 and deliver fuel to the burner nozzle 61, in the manner previously described. Since the spark is continuous, the fuel will be ignited immediately upon discharge from the burner nozzle 61. The volume of the heating coil 35 is small so that the solution upon initial operation is heated to the desired operating temperature within a matter of a few minutes. After the solution has been brought to the operating pressure, the solution-pumping section 73 of the pump 7 will continue the discharge thereof through the cleaning gun 47. While the cleaning gun 47 is in use, the restrictor 48 will maintain a flow rate of about 30 gallons per hour and maintain the desired back-pressure on the solution system. During normal operation, the aforesaid flow rate through the heating coil 35 is such that the solution is adequately heated while it is passing through said coil. The unit can be shut down by stopping the motor 9 and closing the fuel valve 70.

FIG. 5 is a perspective view of a complete portable steam cleaner unit 1 embodying the elements previously described and diagrammatically shown in FIG. 1. Those elements which are visible in FIG. 5 have been identified by the same reference numerals applied to FIG. 1. However, FIG. 5 shows the majority of the components enclosed by a hood secured to frame members 273 and 275 on opposite sides of the unit by screws 277. The frame members 273 (only one of which is shown) are located adjacent the forward end of the fuel tank 65 and have an axle 279 attached thereto upon which wheels 281 are mounted. The frame members 275 are located adjacent the rear end of the fuel tank 65 and have support legs 283 secured thereto by bolts 285. The legs 283 have a guide handle 287 attached thereto to facilitate moving of the unit from one place to another.

FIG. 6 illustrates the steam cleaner 1 mounted for use as a stationary unit, and wherein it is directly positioned upon the upper end of a solution tank 3a. The unit 1 is supported upon the tank 3a by having the frame members 273 and 275 at one side of the unit, positioned against the rim 289 of the solution tank 3a, with the bottom of the fuel tank 65 resting along one of its edges upon said rim. The unit 1 is further supported upon the solution tank 3a by a bracket 291 extending across the top of the solution tank and fastened to the opposite edge of the fuel tank 65, and resting upon the rim 289. The bracket 291 has down-turned ends 293, which prevent the unit from shifting relative to the solution tank 3a. In this model, the solution supply hose 5a is short and extends directly into the solution tank 3a.

It will be understood that various changes may be made in the details of construction and in the arrangement of parts described hereinbefore, without departing from the principles of the invention or the scope of the annexed claims.

I claim:

1. A liquid heating system, comprising: a heating coil for heating liquid while flowing therethrough; burner means arranged to heat the liquid in said heating coil; and means including a liquid and fuel pump assembly for simultaneously pumping liquid to said heating coil and for pumping fuel to said burner, said pump including means for pumping said fuel that is actuated in response to impulses created in the pumping of said liquid whereby in the absence of liquid to be pumped, no fuel will be pumped to the burner.

2. A steam cleaner device, as defined in claim 1, in which the pump includes means actuated in response to the pumping impulses of the fuel for regulating the amount of fuel supplied to the burner means.

8

3. A liquid heating system, comprising: a liquid heater; conduit means connected to said liquid heater for supplying liquid thereto; burner means for heating said liquid heater; conduit means connected to said burner means for supplying fuel thereto; a liquid and fuel pump assembly connected with said conduits, respectively, for simultaneously pumping liquid and fuel through said respective conduits, said pump including means for impulse-pumping said liquid, and means for pumping said fuel actuated in response to the impulses created in the liquid being pumped so that impulses provided to pump said liquid to said liquid heater also effect pumping of fuel to said burner means, whereby in the absence of liquid to be pumped, no fuel will be pumped to said burner means; and means connected with said pump for actuating said pump to provide said pumping impulses.

4. A liquid heating system as defined in claim 3, in which the combined liquid and fuel pump comprises separate liquid and fuel-pumping chambers separated by a membrane, and wherein one of said chambers has an outer wall formed by a flexible diaphragm; and wherein the means for actuating the pump imparts pulsations to said diaphragm.

5. A liquid heating system as defined in claim 3, wherein the pump includes a flexible diaphragm forming an outer wall for the other chamber, and wherein the last-mentioned diaphragm is spring-loaded to control the pressure at which liquid is discharged from said other chamber.

6. A liquid heating system as defined in claim 3, in which the combined liquid and fuel pump comprises separate liquid and fuel-pumping chambers separated by a membrane, and wherein the liquid pumping chamber has an outer wall formed by a flexible diaphragm, and wherein the means for actuating the pump imparts pulsations to said diaphragm, and wherein the fuel-pumping chamber has an outer wall formed by a flexible diaphragm, and wherein the last-mentioned diaphragm is springloaded to control the pressure at which fuel is delivered to the burner.

7. A liquid heating system as defined in claim 3, including a combined back-pressure regulator and pulse absorber located in the liquid supply conduit at a point between the pump and the heater.

8. A liquid heating system as defined in claim 3, including a combined back-pressure regulator and pulse absorber located in the liquid supply conduit at a point between the pump and the heater, and wherein said back-pressure regulator and pulse absorber includes a spring-loaded diaphragm.

9. A liquid heating system as defined in claim 3, in which the pump includes a chamber for pumping liquid to the liquid heater, and wherein a conduit is connected with said chamber and leads to a means externally of said chamber containing a pair of oppositely arranged one-way check valves for controlling the admission and discharge of liquid from said chamber through said conduit.

10. A liquid heating system, comprising: a source of supply of liquid to be heated; a liquid heater; conduit means connecting said source of liquid to said liquid heater; burner means for heating said liquid heater; a source of supply of liquid fuel; conduit means connecting said source of liquid fuel to said burner means; a liquid and fuel pump assembly connected in said liquid and said fuel supply conduits, respectively, for simultaneously pumping said liquid and said fuel through said conduits, said pump including means for impulse-pumping said liquid, and means for pumping said fuel actuated in response to the impulses created in the liquid being pumped so that impulses provided to pump said liquid into said liquid heater also effect pumping of fuel to said burner means, whereby in the absence of liquid to be pumped, no fuel will be pumped to said burner means; and means connected with said pump for actuating said pump,

11. A liquid heating system, comprising: a tank for liquid to be heated; a heating coil; conduit means connecting said liquid tank to said heating coil; burner means for heating said heating coil, a fuel tank, conduit means connecting said fuel tank to said burner means; a liquid and fuel pump assembly connected in said liquid and fuel conduits, respectively, for simultaneously pumping said liquid and said fuel through said conduit means, said pump having separate chambers for pumping said liquid and fuel; a membrane forming a flexible wall between said chambers; a pumping-diaphragm forming an outer wall for said liquid-pumping chamber; means connected with said pumping-diaphragm for flexing said diaphragm forward and away from said liquid-pumping chamber to impart pulses to the liquid therein and through said liquid and said membrane to impart pulses to the fuel in said fuel-pumping chamber, whereby in the absence of liquid to be pumped in said liquid-pumping chamber, the pumping of fuel in said fuel-pumping chamber will be immediately discontinued; and means for actuating said pump.

12. A multiple pump for simultaneously pumping two different liquids, comprising: a closed, fluid tight pump housing; a flexible pumping membrane extending across the interior of said pump housing and dividing the same into a first chamber for pumping a first liquid and a second chamber for pumping a second liquid; a flexible pumping diaphragm forming an outer wall of the first chamber, said first chamber having a passage through which liquid to be pumped is admitted into and discharged from said first chamber; means providing a chamber for receiving liquid to be pumped communicating with said passage and having a pair of check valves mounted therein in spaced relation permitting the flow of liquid therethrough in only one direction, said second pumping chamber having an inlet and an outlet for said second liquid; one-way check valve means controlling the flow of said second liquid through said last-mentioned inlet and outlet, respectively; and means connected to said pumping diaphragm for flexing said diaphragm back and forth to impart pulses to liquid in said first chamber to effect pumping thereof and to impart pulses to liquid in said second chamber through said pumping membrane to effect pumping of said second liquid.

13. A multiple pump as defined in claim 12, wherein a flexible diaphragm forms a wall for the second chamber, and wherein means is provided for limiting the extent of flexing of said last-mentioned diaphragm to control the displacement and pressure at which the second liquid is pumped.

14. The method of operating a liquid heater wherein liquid is to be heated in a heating coil and a liquid fuel is to be supplied to a burner to heat the liquid in said heating coil comprising the step of: imparting impulses to the liquid to be heated to deliver said liquid to said heating coil; and transmitting impulses from said liquid to the fuel to effect delivery of said fuel to said burner, whereby in the absence of liquid to be delivered to the heating coil, no fuel can be delivered to the burner.

15. A multiple pump for simultaneously pumping two different liquids, comprising: housing means comprising housing members having a flexible pumping membrane therebetween and extending across the interior thereof and dividing the same into a pair of pumping chambers for pumping different liquids, said housing means also including housing members between which a pumping diaphragm is disposed to form a wall of said one chamber; said flexible pumping membrane forming a wall of said other chamber; means for flexing said pumping diaphragm back and forth for producing a pulse action in said one chamber to effect pumping of liquid in said one chamber, said flexible pumping membrane being re-

sponsive to the pumping pulses imparted to the liquid in said one chamber and transmitting said pulses to the liquid in said other chamber to effect pumping thereof; and adjustable means responsive to the pumping of liquid in said other chamber and disposed exteriorly of said other chamber effective to vary the volume and pressure of the liquid pumped from said other chamber.

16. A multiple pump for simultaneously pumping liquid and fuel to a heating coil and burner, respectively, of a steam cleaner or the like, comprising: housing means providing a liquid pumping pulse chamber, and a fuel pumping chamber; a flexible pumping diaphragm closing one end of said liquid pumping pulse chamber, said housing means having a wall forming a portion of said liquid pumping pulse chamber provided with a passage through which liquid is admitted into and expelled from said liquid pumping pulse chamber to effect pumping of said liquid, said housing means providing an additional chamber for liquid communicating with said passage and having an inlet containing a liquid inlet check valve and an outlet containing a liquid outlet check valve mounted therein in spaced relation and controlling the flow of liquid through said additional chamber in only one direction; a flexible membrane forming one end of said fuel pumping chamber, said fuel pumping chamber having an inlet containing a fuel inlet check valve and an outlet containing a fuel outlet check valve mounted therein for controlling the flow of fuel therethrough in only one direction, said housing means having an opening through which impulses imparted to the liquid by said pumping diaphragm are transmitted to said flexible membrane to effect pumping of said fuel; and means connected with said pumping diaphragm for flexing said pumping diaphragm back and forth to impart pulses to liquid in said liquid pumping chamber to be transmitted by said flexible membrane to fuel in said fuel pumping chamber to effect pumping of said fuel, whereby in the absence of liquid to be pumped to a heating coil, no fuel can be pumped to the burner for heating the coil.

17. A multiple pump as defined in claim 16, including means responsive to the pressure of the fuel being pumped for controlling the pressure and the volume of fuel being pumped from said fuel pumping chamber.

References Cited by the Examiner

UNITED STATES PATENTS

702,491	6/1902	Serpollet	122—448
815,713	3/1906	Joslin	239—130
1,647,768	11/1927	Berdon	103—37
1,719,060	7/1929	Lamblin	103—37
1,840,527	1/1932	Rabazzana	103—44
1,855,866	4/1932	Ofeldt	122—448
2,123,166	7/1938	Clarkson	122—448
2,427,818	9/1947	Taylor	103—44
2,585,575	2/1952	Nedergaard	137—510
2,987,053	6/1961	Arant	122—451
2,987,259	6/1961	Lindquist	122—250
3,064,631	11/1962	Schwander	122—451
3,106,219	10/1963	Teston	137—510
3,131,676	5/1964	Telford	122—451

FOREIGN PATENTS

330,598	8/1903	France.
605,784	11/1934	Germany.
291,664	12/1931	Italy.

KENNETH W. SPRAGUE, *Primary Examiner.*

MEYER PERLIN, ROBERT A. O'LEARY,
FREDERICK L. MATTESON, JR., *Examiners.*

D. G. BLACKHURST, *Assistant Examiner.*