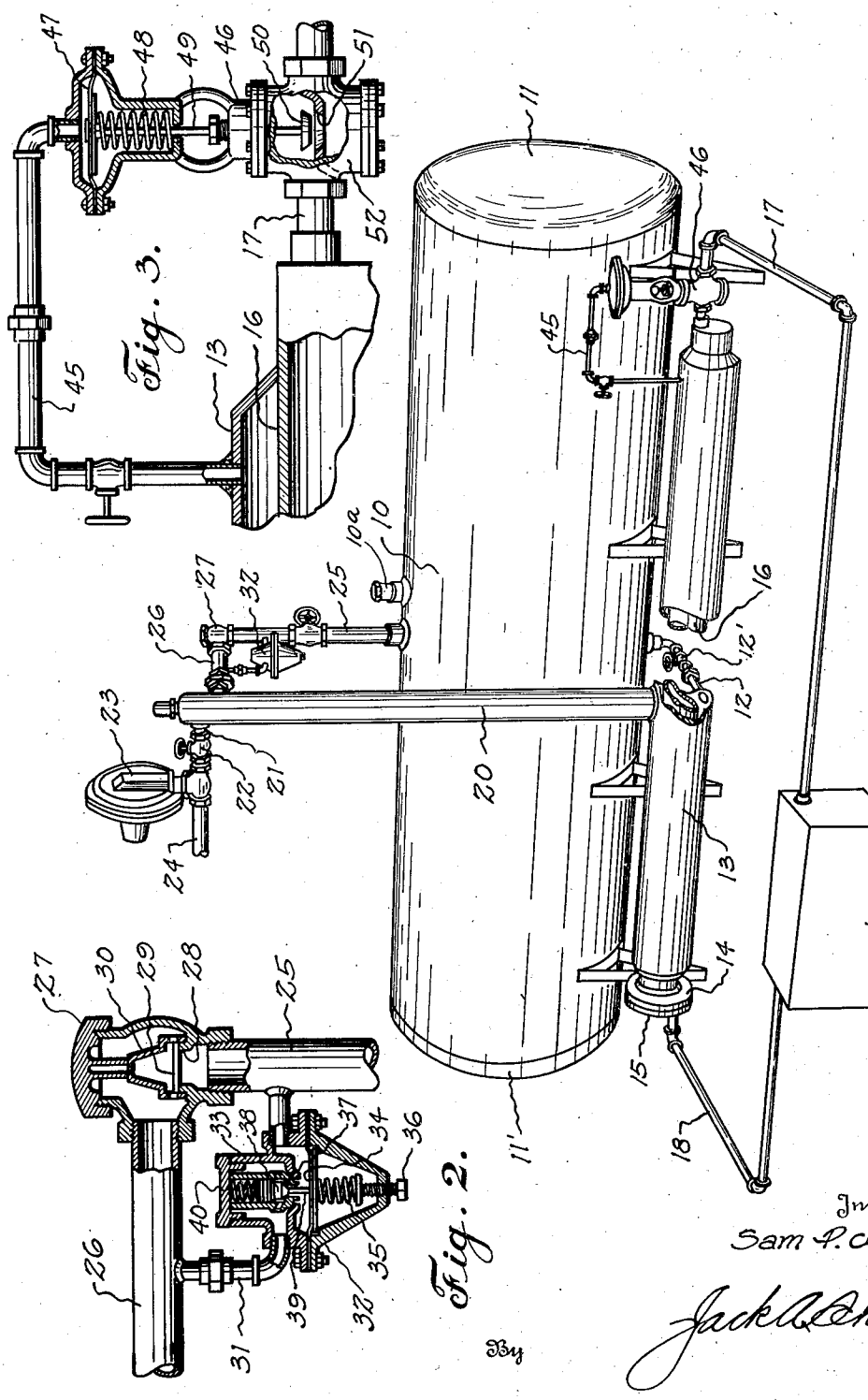
Sept. 16, 1941. S. P. JONES 2,255,747

MEANS FOR VAPORIZING HYDROCARBON LIQUIDS

Filed Dec. 24, 1937 2 Sheets-Sheet 1



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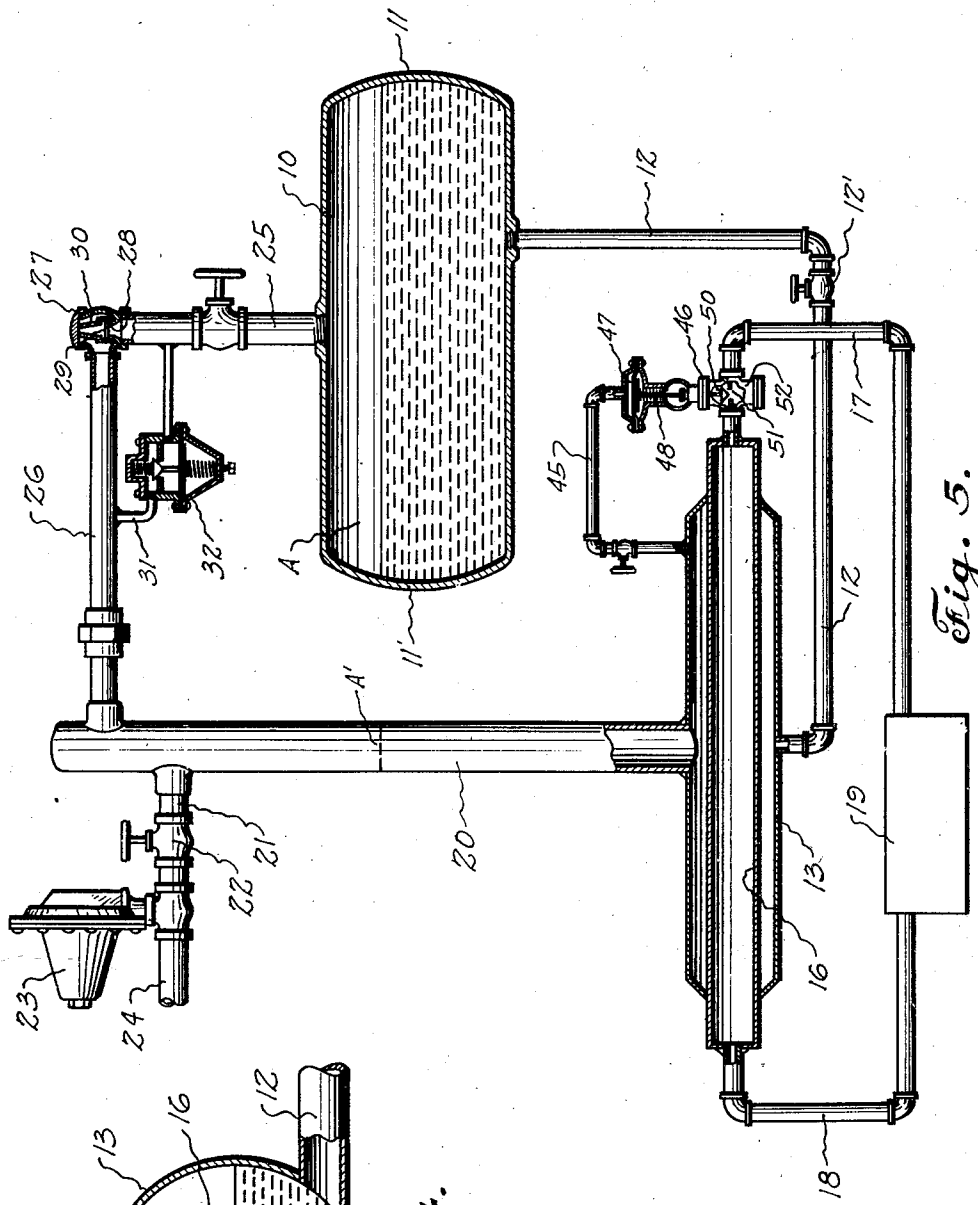


Fig. 5.

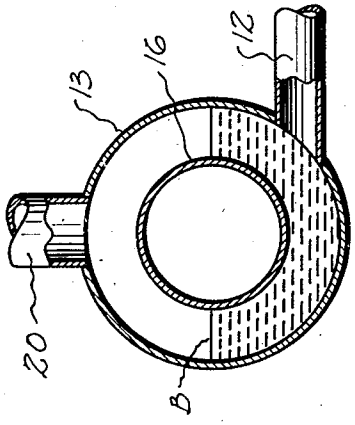


Fig. 4.

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MEANS FOR VAPORIZING HYDROCARBON LIQUIDS

Sam P. Jones, Dallas, Tex.

Application December 24, 1937, Serial No. 181,681

5 Claims. (Cl. 62—1)

This invention relates to new and useful improvements in methods of and means for vaporizing hydrocarbon liquids.

This application is filed as an improvement in my copending application, filed December 15, 1934, Serial No. 757,686.

The apparatus disclosed in my copending application, above referred to, was primarily designed for vaporizing hydrocarbons, having a comparatively low boiling point, for use as fuel in motor vehicle engines, wherein the demand for the gaseous fluid or gas varies in accordance with the speed of, and load imposed on, the engine, with the result that more or less vaporization occurs as the load or requirement changes. Such variation in the amount of gas generated produces, as is clearly explained in my previous application, a constant interflow of the hydrocarbon liquid in the vaporizing chamber with the liquid in the storage chamber. The liquid in the vaporizing chamber is, of course, heated and as it flows back into the storage chamber, it transmits heat to the stored body of liquid, whereby the stored liquid is maintained at a temperature sufficient to produce a pressure or supply of vapor or gas above the stored body of liquid. This supply of gas above the liquid is utilized to supply the demand to the engine, or other apparatus which is operated by the gas.

It has been found that so long as the apparatus is supplying a variable speed engine, which varies the demand for fuel, the interflow of heated liquid with the liquid in the chamber continues, whereby the vapor pressure above the stored liquid is maintained. However, when the apparatus is employed with an engine or motor, which operates at a constant speed, such interflow of heated liquid does not occur because the generated gas is entirely used by the engine and there is never an excessive pressure within the vaporizing chamber, such excessive pressure being necessary to force the heated liquid back into the liquid in the storage chamber. Therefore, when applied to a constant speed engine, the flow of liquid is in one direction only, from the storage chamber to the vaporizing chamber, and additional heat is not transferred to the stored body of liquid because there is no interflow.

It is, therefore, one of the objects of this invention to provide an improved hydrocarbon vaporizing system adapted to supply fuel to a constant speed engine and having means for maintaining a vapor pressure above the stored body of liquid, whereby a constant supply of gas is available at all times to supply the demand under varying atmospheric conditions.

An important object of the invention is to provide an improved apparatus, of the character described, wherein the gaseous fluid or gas which is generated in the vaporizing chamber is introduced into the storage chamber to add heat to the liquid within the chamber and thereby maintain a vapor pressure above said stored body of liquid.

A particular object of the invention is to provide pressure actuated means for controlling the admittance of the generated gas to the storage chamber, whereby said gas is admitted as needed so as to maintain the vapor pressure within the tank at a predetermined pressure.

Still another object of the invention is to provide an improved method of vaporizing hydrocarbon liquids which includes, confining a body of liquid whereby vaporization occurs to release gases from said body, accumulating such gases, heating a portion of the liquid to generate additional gas, and admixing a portion of the generated gas with the accumulated gas when the pressure of the latter falls below a predetermined point, whereby the vapor pressure of the accumulated gas is maintained at a predetermined point.

A further object of the invention is to provide an improved apparatus of the character described, having means for automatically reducing the applied heat when the pressure of the generated gas exceeds a predetermined point.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, in which an example of the invention is shown, and wherein:

Figure 1 is a perspective view of a vaporizing apparatus constructed in accordance with the invention, for carrying out the improved method,

Figure 2 is an enlarged view partly in elevation and partly in section of the check valve and by-pass line, together with the pressure control valve in said by-pass line,

Figure 3 is an enlarged view of the pressure actuated safety valve,

Figure 4 is an enlarged transverse, vertical, sectional view taken through the central portion of the vaporizing chamber, and

Figure 5 is a schematic or diagrammatical view of the apparatus.

It is pointed out that as used herein the term "gas" is intended to cover all products of vaporization of the hydrocarbon liquid which is used.

In the drawings, the numeral 10 designates an elongate tank or reservoir which is preferably cylindrical in shape and which has its ends closed by cover plates 11 and 11'. The tank or reservoir receives the liquid hydrocarbon which is to be vaporized and this liquid is preferably butane, or other similar product which has a comparatively low boiling point. The reservoir thus forms a storage chamber for the liquid.

An outlet pipe 12 extends from the bottom of the container and has its outer end connected with an elongate, tubular housing or casing 13 which forms a vaporizing chamber. The housing is shown as extending in parallel relation to the reservoir and one end of said housing is closed, while its opposite end is open and surrounded by an annular flange 14. A circular closure plate 15 is bolted to the flange and closes the open end of the housing and by removing said plate, access to the interior of the vaporizing chamber, for cleaning, or other purposes, may be had. The liquid from the reservoir 10 may flow into the elongate, tubular housing and such flow may be controlled by a valve 12', connected in the line 12. During normal operation, the valve is wide open so that an unrestricted flow from the reservoir to the vaporizing chamber may occur.

For heating the liquid within the vaporizing chamber 13, a conduit or pipe 16 is disposed axially within the tubular chamber, extending throughout the length thereof. One end of the conduit is connected to an inlet pipe 17 which extends through the closed end of the vaporizing chamber, while its other end is connected to an outlet 18, which passes through the closure plate 15. Both the inlet and outlet have connection with a boiler, or heating unit, 19, whereby a constant circulation of hot water, or other heating medium, may be maintained through the axial conduit. The circulation of a heating medium through the conduit heats the liquid within the vaporizing chamber and vaporizes said liquid to produce gas.

The vaporized products rise in the chamber 13 and pass upwardly into a vertical riser pipe or stack 20 extending upwardly from the tubular casing 13, which forms said vaporizing chamber. The riser pipe or stack 20 which has its lower end communicating with the tubular casing 13 forms a receiving chamber for receiving the vaporized products. The extreme upper end of the riser pipe is closed and a lateral outlet pipe 21 has one end connected to the upper portion of the riser. A control valve 22 is mounted in the outlet 21 and beyond said valve, a pressure regulator 23, of the usual construction, is connected in said outlet. Manifestly, the gas generated in the vaporizing chamber 13, rises in the stand pipe 20 and flows through the outlet 21 and then through the regulator, wherein the pressure of said gas is regulated. From the regulator, the gas is conducted to the engine, or other source of consumption (not shown) by a suitable feed or supply line 24.

The top of the reservoir or tank 10 has a vertical conductor 25 extending upwardly therefrom, while a lateral pipe or conductor 26 extends from the upper portion of the riser 20, and these conductors are connected at their free ends by an elbow 27. A valve seat 28 is formed within the elbow (Figure 2) and a valve disk 29 is arranged to seat on said seat, being confined and guided in its movement within a suitable valve cage 30. The valve disk comprises a check valve which upon upward movement, is unseated to permit a flow from the reservoir 10 to the riser pipe or receiving chamber 20. Obviously, the disk is moved by the pressures on each side thereof and when the pressure in the riser, acting against the upper surface of the disk, exceeds the pressure within the reservoir, the valve disk is seated to prevent communication between the riser and reservoir. A greater pressure in the reservoir, acting beneath the valve, will unseat the same to establish communication between the reservoir and riser. The weight of the valve disk is, of course, added to the pressure acting against the top of said disk because of gravitational force urging said valve to its seat.

The above described parts, with slight modifications in structure, comprise the generating apparatus disclosed in my copending application, hereinbefore referred to, and operate in substantially the same manner.

In operation, the liquid hydrocarbon is introduced into the reservoir 10 through an ordinary fill pipe 10a or in any other suitable manner. For the purposes of this description, butane will be used and it will be supposed that the atmospheric temperature is 60 degrees Fahrenheit. When the liquid butane is introduced into the reservoir, the butane will flow through the pipe 12 and into the vaporizing chamber 13 and then into the riser pipe 20, whereby the liquid level in the riser and reservoir will equalize as shown by the dotted lines in Figure 5. The boiling point of liquid butane is 33 degrees at atmospheric pressure and therefore, since the atmospheric temperature is 60 degrees Fahrenheit, the space A above the liquid level in the reservoir, as well as the space above the liquid in the riser 20, becomes filled with vaporized butane, or butane gas at a pressure of 12 pounds which is the vapor pressure of butane at 60 degrees Fahrenheit.

So long as the temperature remains the same, no further vaporization takes place. It is pointed out that at this time, with the liquid levels in the reservoir and the riser pipe equal, there is an equal gas pressure above and below the valve 29. Due to the weight of this valve and the equal pressures on each side thereof, said valve is held closed.

Assuming the feed line 24 to be connected with an internal combustion engine, which is to be operated by the gas generated by the apparatus, it will be manifest that when the engine is turned over, the suction of its pistons will act through the pipe 24 and regulator 23, and also through the pipes 21 to draw gas from the interior of the riser pipe 20. A supply of gas is always present in the upper portion of the riser pipe 20 above the liquid level and therefore no auxiliary heater need be applied to the system to generate gas before starting the engine. As soon as the engine is started, or as soon as a suction is applied to the pipe 24, the gas supply in the riser 20 is drawn therefrom. This immediately reduces the gas pressure within the riser and the liquid level in the riser pipe 20 begins to rise, due to the weight of the body of liquid and the vapor pressure within the reservoir 10, which liquid and pressure are acting on the liquid in the riser pipe through the pipe 12. Naturally, when the liquid within the pipe 20 rises, the liquid level within the reservoir 10 falls. By this time the gas pressure above the valve disk has decreased

to a point where the pressure therebelow is sufficient to overcome this decreased pressure plus the weight of the valve to raise said valve, thereby permitting the gas which is stored above the liquid level in the reservoir to be drawn through the conductor pipes 25 and 26, into the upper portion of the riser pipe 20 and then to the pipes 21 and 24. From the pipe 24, this gas is, of course, directed to the source of consumption. It is pointed out that the weight and the size of the valve disk 29 will control the pressure necessary to open the same, and by varying the size of this valve, the level to which the liquid in the riser 20 will rise, after the gas pressure thereabove is decreased and before the valve disk 29 is opened, may be positively controlled. The maintenance of a vapor pressure above atmospheric, within the reservoir provides a reserve gas supply which is available for use when the gas demand exceeds the capacity of the vaporizing unit.

As the gas is drawn off from above the liquid level in the reservoir 10, more gas is automatically generated. As this vaporization continues, heat is extracted from the body of liquid within the reservoir, thereby lowering the temperature of said liquid. Assuming that the temperature was 60 degrees at the start, the increased vaporization would cause it to drop and when a temperature falls to 55 degrees, for example, the vapor pressure would be nine pounds. Continued drop in the temperature of the liquid would cause a resultant drop in gas pressure accordingly and a pressure above atmospheric would be had up to the time when the liquid temperature would reach 33 degrees Fahrenheit at which point the vapor pressure would be atmospheric.

However, in actual practice, the boiler or heating unit 19 is started at the time that the gas is first drawn from the riser pipe 20. By the time the gas pressure within the reservoir 10 has fallen three pounds, or less, the heating unit has been operating sufficiently long to heat the water circulating through the axial conduit 16 within the vaporizing chamber 13. The circulation of this hot water through the vaporizing chamber immediately heats the liquid butane standing within said chamber and immediately generates gas which rises within the pipe 20. As soon as this gas pressure within the pipe 20 equals the pressure above the liquid in the reservoir, the valve 29 is closed and the gas drawn from the pipe 20 is that generated in the chamber 13. This valve remains closed until a condition again arises which reduces the pressure in the riser pipe 20. Such condition might occur if a sudden overload is placed on the engine (not shown) in which case the gas being generated would be insufficient to supply the demand and gas from the reservoir would be used to automatically take care of the changed conditions.

When the circulation of hot water through the conduit 16 is first begun, it will be manifest that the entire conduit is surrounded or submerged in the liquid within the vaporizing chamber. This is true because the liquid level is at the point A' within the riser pipe 20. Obviously, since the entire surface of the conduit 16 is contacting the liquid butane standing in the vaporizing chamber, a relatively large amount of gas is generated. Assuming that a constant volume of gas is being drawn through the pipes 21 and 24, it will be obvious that an excess gas pressure will be built up in the riser pipe. In other words, more gas than is necessary for the demand is generated. This gas pressure which is built up in the pipe 20 acts downwardly on the liquid level in said pipe and naturally such gas pressure will exceed the pressure of the gas which is trapped above the liquid level in the reservoir 10. Therefore, the gas pressure built up in the riser pipe 20 will force the liquid downwardly through said pipe and back into the tank or reservoir 10. The level in the vaporizing chamber will be moved downwardly to a point B (Figure 4) where sufficient liquid is contacting the conduit 16 to generate sufficient gas for the demand. This constant level in the vaporizing chamber will be determined by the demand or by the amount of gas withdrawn from the riser 20. So long as such demand remains constant, the liquid level in the vaporizing chamber will remain substantially constant and after this balanced condition is reached after the starting of the apparatus, said level will not vary materially.

With such arrangement, it will be manifest that the gas is generated in accordance with the demand and the flow of liquid butane is always from the reservoir or tank 10 to the vaporizing chamber 13. After the initial starting, no heat is applied to the liquid in the reservoir or tank and therefore if the atmospheric temperature should drop, the liquid within said reservoir would be cooled. If this temperature should fall to a point below 33 degrees Fahrenheit, the condensation which would occur within the reservoir would cause the vapor pressure above the liquid in said reservoir to fall below atmospheric. If such a condition were to occur, there would be an insufficient vapor pressure in the reservoir to supply the demand and auxiliary heat would be necessary to restore the vapor pressure within said reservoir.

In order to maintain the vapor pressure above the liquid level in the reservoir or tank 10, a by-pass line 31 has one end connected to the pipe or conductor 26 and its other end connected to the pipe 25. A pressure-operated diaphragm valve 32 is connected to the by-pass 31 and controls the flow therethrough. The valve includes a case or housing 33 having a diaphragm 34 extending transversely thereacross. A coiled spring 35 is located beneath the diaphragm and constantly urges the same upwardly. An adjusting screw 36 engages the lower end of the spring and by adjusting said screw, the tension on the spring may be varied. As is clearly shown in Figure 2, the upper end of the diaphragm is subjected to the pressure within the pipe 25, which is the pressure within the tank 10 above the liquid level.

An annular valve seat 37 is formed within the valve case 33 above the diaphragm 34 and this seat is adapted to be engaged by a valve member 38 which is secured to a stem 39 which extends upwardly from the diaphragm. When the diaphragm undergoes movement within the case, the valve member 38 is engaged or disengaged from its seat 37. A coiled spring 40 exerts its pressure downwardly on the valve member 38 and this spring is smaller and of less pressure than the spring 35 beneath said diaphragm.

The diaphragm controls the opening of the valve member 38 and has its upper end subjected to the pressure of the gas or vapor within the tank 10. The lower end of said diaphragm is engaged by the coiled spring 35 which is constantly urging the diaphragm upwardly, whereby the valve member 38 will be moved from its seat 37. The valve member is, of course, held in

its closed or seated position by the pressure of the vapor within the reservoir 10. When the vapor pressure within said reservoir drops below a predetermined point, the spring 35 acting against the opposite or lower end of the diaphragm moves said diaphragm upwardly, whereby the valve member 38 is unseated to establish communication between the pipe 26 and the conductor 25. When this occurs, the gas within the riser 20 and pipe 26 may flow through the by-pass line 31 and enter the interior of the reservoir 10 above the liquid therein.

Normally, the valve 32 is closed whereby a flow between the pipe 25 and the pipe 26 is cut off. The adjusting screw 36 is adjusted so as to place a proper tension on the spring 35. The apparatus is put into operation as has been described, and so long as the vapor pressure above the liquid level in the reservoir or tank 10 is sufficent, so that vapor or gas is available at all times, the valve 32 remains closed. The valve disk 29 will, of course, be operated at the start, as has been explained, to permit gas to be drawn from the reservoir. After the apparatus has been operating for some time and the liquid level in the vaporizing chamber 13 has reached its standing level, sufficient gas is generated in the riser pipe 20 to supply the demand. If for any reason, the vapor pressure within the reservoir 10 should fall below the pressure at which the valve 32 is set to open, the spring 35 will raise the diagram 34 and unseat the valve member 38. When this occurs, the gas from the riser 20 may pass through the pipe 26 and then through the by-pass 31 and into the pipe 25 from where it may enter the reservoir 10 above the liquid level therein. This gas contains within itself the latent heat of vaporization and would act to heat the liquid within the reservoir sufficiently to maintain the vapor pressure within the reservoir so that sufficient gas is available at all times. Manifestly, by setting or adjusting the screw 36, the valve 32 may be set to open at any predetermined pressure, whereby it is possible to maintain the vapor pressure within the reservoir at a fixed and predetermined amount. By maintaining the vapor pressure in the reservoir, gas is available at all times and under varying atmospheric temperatures and conditions, to supply the demand.

In the event that either the valve 29 or the valve 32 should fail for any reason whatever, a communication between the pipe 20 and the reservoir 10 would be established. In such event, the pressures above the liquid in the vaporizing chamber and above the liquid in the reservoir would equalize, whereby the liquid in the pipe 20 would seek the same level as the liquid in the reservoir 10. This would cause the liquid in the vaporizing chamber 13 to completely submerge the conduit 16 through which the hot water is circulated, whereby a greater amount of gas would be generated. This increased amount of gas would exceed the demand, with the result that an increased gas pressure would be built up in the system. To prevent the building up of an excessive pressure, due to the failure of either of the valves 29 or 32, a pipe 45 has one end connected to the vaporizing chamber 13, while its other end is connected to the hot water inlet pipe 17. A diaphragm valve 46 is connected in the pipe 45 and this valve includes a transverse diaphragm 47 which is movable within the valve case. The upper end of this diaphragm is exposed to the pressure within the vaporizing chamber, which pressure tends to move the diaphragm downwardly. A coiled spring 48 engages the lower end or underside of the diaphragm and resists its movement by the pressure within the vaporizing chamber. An axial valve stem 49 extends downwardly from the diaphragm and has valve member 50 on its lower end. A valve seat 51 is formed within a valve case 52 connected in the inlet line 17. The spring 48 which engages the underside of the diaphragm is of such tension that, under normal conditions, the valve 50 is held open, whereby the hot water may circulate through the conduit 16. In the event that an excessive pressure is built up within the system, such pressure acts downwardly on the diaphragm 47 and moves the valve member 50 into engagement with its seat 51, whereby the circulation of hot water through the conduit is shut off. The shutting off of the circulating hot water shuts off the application of heat to the liquid within the vaporizing chamber, with the result that no gas is generated by applied heat during the time that the hot water is not circulating through the conduit. This permits the pressure in the system to drop, as the withdrawal of gas from the pipe 20 continues and as soon as such pressure returns to normal, the valve 50 is again opened and the heating of the liquid within the vaporizing chamber is again started. Thus, it will be seen that the valve 46 is a safety feature, which prevents the building up of an excessive pressure within the system. This valve operates only in the event that one of the valves 29 or 32 fails; otherwise, it is inactive and dormant.

What I claim and desire to secure by Letters Patent is:

1. A vaporizing apparatus for hydrocarbon liquids including, a reservoir for storing liquid and having a space above the liquid level forming a gas chamber for storing gas vaporized from the stored body of liquid, a vaporizing chamber connected with the reservoir so as to permit liquid from said reservoir to flow to the vaporizing chamber, a receiving chamber communicating with both the gas chamber and vaporizing chamber, means for controlling the supply of gas from the gas chamber of the reservoir to the receiving chamber by the pressure differential in said chambers, and means for conducting gas from the receiving chamber into the gas chamber when the pressure in said gas chamber falls to a predetermined point, said last named means being unaffected by the pressure in the receiving chamber.

2. A vaporizing apparatus for hydrocarbon liquids including, a reservoir having liquid therein and having a space above the liquid level forming a gas chamber for storing gas vaporized from the stored body of liquid, a vaporizing chamber connected with the reservoir so as to permit liquid from said reservoir to flow to the vaporizing chamber, a receiving chamber above the vaporizing chamber and communicating with the vaporizing chamber, a conductor leading from the upper portion of the receiving chamber to the gas chamber, a check valve in the conductor operated by the differential in pressures between the receiving chamber and the gas chamber for controlling the flow of gas from the gas chamber to the receiving chamber, a by-pass line connected in the conductor and by-passing the check valve, and valve means in the by-pass line and arranged to be opened when the pressure in said gas chamber falls below a predetermined point to permit a flow of gas from the receiving chamber to the gas chamber.

3. A vaporizing apparatus for hydrocarbon liquids including, a liquid reservoir having a space above the liquid level forming a gas chamber for storing gas vaporized from the stored body of liquid, a vaporizing chamber connected with the reservoir so as to permit liquid from said reservoir to flow to the vaporizing chamber, a receiving chamber above the vaporizing chamber and communicating with the vaporizing chamber, a conductor leading from the upper portion of the receiving chamber to the gas chamber, a check valve in the conductor operated by the differential in pressure between the receiving chamber and the gas chamber for controlling the flow of gas from the gas chamber to the receiving chamber, a by-pass line connected in the conductor and by-passing the check valve, and a valve mounted in the by-pass line actuated by the pressure within the gas chamber and arranged to be opened to permit a flow from the receiving chamber to the gas chamber when the pressure in said gas chamber falls below a predetermined point.

4. A vaporizing apparatus for hydrocarbon liquids including, a reservoir having liquid therein and having a space above the liquid level forming a gas chamber for storing gas vaporized from the stored body of liquid, a vaporizing chamber connected with the reservoir to permit liquid from said reservoir to flow to the vaporizing chamber, a receiving chamber above the vaporizing chamber and communicating with the vaporizing chamber, means for applying heat to the vaporizing chamber to vaporize the liquid therein and produce gas which flows into the receiving chamber, a conductor leading from the upper portion of the receiving chamber to the gas chamber, a check valve in the conductor operated by the differential in pressures between the receiving chamber and the gas chamber for controlling the flow from the gas chamber to the receiving chamber, a by-pass line connected in the conductor and by-passing the check valve, valve means in the by-pass line and arranged to be opened when the pressure in said gas chamber falls below a predetermined point to permit a flow of gas from the receiving chamber to the gas chamber, and means for automatically cutting off the applied heat when the pressure in the apparatus exceeds a predetermined pressure.

5. A vaporizing apparatus for hydrocarbon liquids including, a liquid rservoir having a space above the liquid level forming a gas chamber at its upper end, a tubular vaporizing chamber connected with the lower end of said reservoir whereby liquid from the reservoir may flow into the vaporizing chamber, a stand pipe forming a receiving chamber extending upwardly from the vaporizing chamber and communicating therewith, an axial conduit extending through the vaporizing chamber, means for circulating a heating medium through the conduit to vaporize the liquid therein to produce gas which rises into the stand pipe, a conductor connecting the upper portion of the pipe with the gas chamber, means in the conductor for controlling the flow from the gas chamber to the pipe, a by-pass line in the conductor by-passing the control means, and a valve in the by-pass line subjected to the pressure within the gas chamber for admitting gas from the stand pipe to the gas chamber when the pressure in the chamber falls to a predetermined point, whereby a desired pressure is maintained in the gas chamber.

SAM P. JONES.