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APPARATUS FOR GENERATING COMBUSTIBLE GAS

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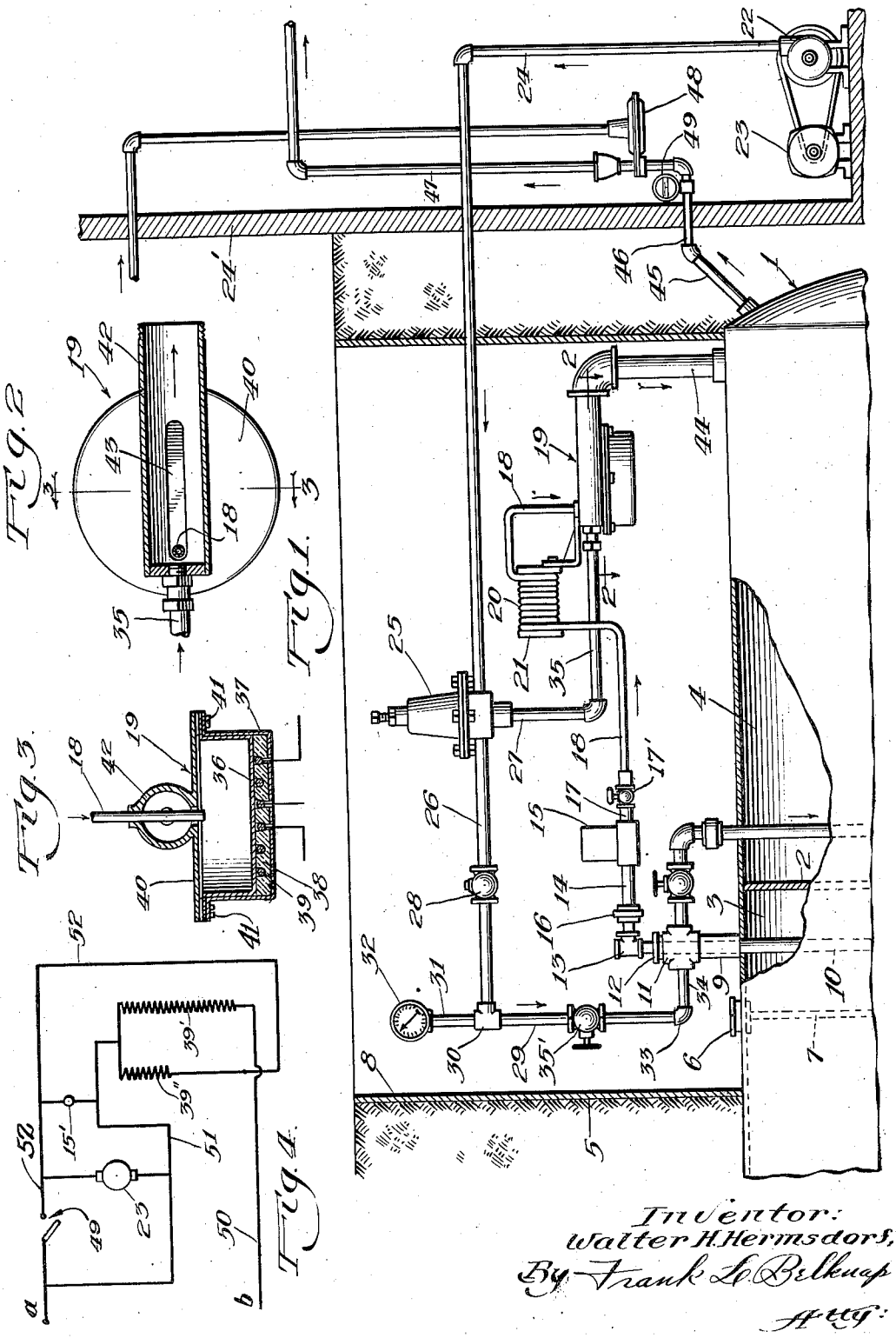


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

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APPARATUS FOR GENERATING COMBUSTIBLE GAS

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This invention relates to improvements in a combustible gas generating device particularly adaptable for generating a combustible gas by associating the vapor of a combustible liquid and air.

The utility, objects and advantages of my invention will be apparent from the accompanying drawing and following detail description.

In the drawing, Fig. 1 is a diagrammatic side elevational view of a combustible gas generating installation embodying the principles of my invention.

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1.

Fig. 3 is a sectional view taken on line 3—3 of Fig. 2.

Fig. 4 is a schematic view of the electrical connections.

Referring in detail to the drawing, 1 indicates a tank or vessel which may be divided internally by wall 2 into a liquid compartment 3 and a gas compartment 4, said liquid compartment being adapted to contain a combustible liquid such as hydrocarbon fluid, alcohol, or in general any fluid which when properly associated with air produces a combustible gas which may be used for home or industrial purposes.

The tank 1 may, if desired, be buried in the ground 5 and may be provided with a suitable filler pipe (not shown) which may extend to the surface of the ground and through which combustible fluid may be introduced into the liquid compartment 3. A liquid level gauge 6 may be disposed upon the upper portion of the liquid compartment 3, the operating mechanism of which may depend downwardly into said liquid compartment, as shown diagrammatically at 7. A casing 8 may be mounted upon the upper portion of said tank and may be provided with a suitable removable closure (not shown) which may be disposed adjacent the surface of the ground. A pipe 9 may communicate with liquid compartment 3 of tank 1 concentrically disposed within which is a liquid pipe 10 which may depend into the interior of compartment 3.

Pipe 9 may be connected at its upper end to a conventional cross coupling 11 and pipe 10 may extend through said coupling and may be properly fitted thereto by means of bushing 12. An elbow or the like 13 may be connected at the upper end of pipe 10 and may serve as a communicating means between said pipe and pipe 14, the latter being connected to valve 15. A union 16 may be interposed in pipe 14 and may be adapted to facilitate the connecting of valve 15 into the system. Valve 15, if desired, may be of an automatic type such as a solenoidally operated valve which may be opened or closed by energizing or de-energizing the solenoid contained within the valve. The opposite side of valve 15 may be connected by means of pipe 17 and tubing 18 to a vaporizer 19, the details of which will be hereinafter more fully described. The tubing 18 may be constructed of copper or brass and may be wound intermediate its length in the form of a coil 20 upon a suitable core or spool 21.

It has been found in passing liquid from a liquid compartment to a vaporizing zone such as has been hereinbefore described, that it has been desirable to accurately control the quantity of liquid passing from said compartment to the vaporizer. If a comparatively small quantity of liquid is desired to be passed better results may be obtained by increasing the frictional head of the transmitted liquid rather than by decreasing the size of pipe through which said liquid may pass, that is, instead of utilizing a tubing of a very small internal area to reduce the flow of liquid, it is more desirable to provide a pipe or tubing of relatively larger cross-sectional area and make the length of said latter tubing greater. In this manner, flow of the liquid therethrough is decreased by the frictional resistance of the conduit rather than by its restricted area. By this arrangement foreign particles of solid material entrained in said liquid do not clog the tubing 18 which would undoubtedly be the case if said tubing was of relatively restricted cross-sectional area.

A blower or air compressor 22 may be operated by a motor or the like 23 which may be positioned within a building 24' and which, if desired, may be remotely disposed from tank 1. The outlet port of said blower may be connected by means of pipe 24 to a pressure regulating device 25. Two branch pipes 26 and 27 may communicate with the element 25 and the construction of said latter element is such that free passage of air from pipe 24 to pipe 26 is permitted, but air will not pass from pipe 24 to pipe 27 until the pressure within said element reaches a predetermined maximum. Devices of this character, that is devices similar to the element 25, are commonly used, and it is believed need no detailed description.

A check valve 28 of the conventional type may be interposed in pipe 26, said valve being adapted to open away from element 25. Pipe 26 may be joined with downwardly extending pipe 29 by means of T 30 connected to one leg of which, by

means of nipple 31, is a pressure indicating gauge 32. Pipe 29 may be connected by means of elbow 33 to a branch pipe 34, which in turn may connect with cross coupling 11. If desired, a manually operated control valve 35' may be interposed in pipe 29.

It can readily be seen that upon setting motor 23 in operation compressed air from blower 22 may pass through pipe 24, element 25 and pipes 26, 29 and 34 and said air will be introduced from cross coupling 11 by means of pipe 9 into the upper portion of liquid compartment 3, thereby establishing superatmospheric pressure within said compartment.

When superatmospheric pressure has been established in compartment 3 liquid in said compartment will be forced upwardly through pipe 10, which extends downwardly into said liquid, and will be passed through pipe 14 through solenoid operated valve 15, assuming the same to be opened, through tubing 18 to vaporizer 19 wherein the same will be suitably admixed with air to form a combustible gas, as will be hereinafter more fully described.

It can readily be seen that when air under pressure passes to liquid zone 3 and a superatmospheric pressure is built up within said zone the pressure within pipe 26, and hence within element 25 will be increased until said pressure reaches a predetermined maximum value at which element 25 will act to permit air from blower 22 to pass through pipe 27 and pipe 35 to vaporizer 19. In this manner a suitable quantity of air will be introduced to said vaporizer to mix with the liquid introduced thereinto.

Referring particularly to Figs. 2 and 3, the vaporizer 19 may comprise a container 36 which may, if desired, be constructed circularly in cross-section, or the cross-section of the same may be of any desired form. A second member 37 of form similar to the container 36 may be adapted to surround said container, and a space may be provided between the respective bottoms of the container and the member 37. Said space may be filled with an insulating material such or porcelain or the like 38. The upper portion of said porcelain insulation may be provided with a plurality of concentric annular grooves or, if desired, said grooves may be formed in the shape of a spiral. Electric heating element 39 may be disposed in said groove and may be connected to an external source of electricity in a manner which will be hereinafter more fully described.

The upper portion of the container 36 may be provided with a closure 40 which may be mounted upon said container by means of bolts 41. A conduit 42 may be mounted upon the upper portion of the closure 40, the interior of said conduit being connected to the interior of the container 36 by means of slot 43 provided both in the lower surface of the conduit 42 and registering with a similar slot in said closure. The liquid pipe 18 may pass diametrically through conduit 42 and may discharge within container 36 at substantially right-angles to the bottom of said container. The air pipe 35 connects at one end of the conduit 42 and the opposite end of said conduit is connected by means of pipe 44 to gas compartment 4 of tank 1.

It can readily be seen that when electrical energy is supplied to the heating element 39 and combustible liquid is introduced into container 36 to the pipe 18 said liquid upon contacting the relatively warm surface of the bottom of container 36 will be vaporized. The vapors may pass upwardly through slot 43 and into conduit 42 and may be positively induced into said conduit by the passage of air through the same. In other words, air passing through the pipe 35 and conduit 42 will act as an injector in withdrawing the vapors from the vaporizing chamber. The vapors will thus be admixed with air and a combustible gas may be formed which may be carried through pipe 44 to gas chamber 4. In this manner a combustible gas may be formed which may be carried through pipe 44 to gas chamber 4. Gas from the chamber 4 may be withdrawn through pipe 45, which in turn is connected to branch pipe 46 which may pass into building 24 or to any point of utilization. Pipe 44 may be connected to service pipe 47, and interposed in said latter pipe may be a conventional pressure reducing valve 48 which may reduce the pressure of the gas from compartment pressure to a suitable pressure desirable for consumption purposes. A pipe 48' may connect the reducing valve 48 to the atmosphere. A mercoid switch 49 or any other suitable pressure actuated switch may be interposed in the pipe 46, the purpose of which switch will be hereinafter more fully described.

In carrying out my invention, atmospheric pressure will initially exist within liquid compartment 3 and gas compartment 4. Motor 23 may be actuated, thereby driving air compressor or blower 22, which in turn may deliver air to the member 25. The member 25 may be so adjusted that when a predetermined pressure has been reached within said member, pipes 24 and 27 will be brought into communication with each other. Air under pressure will pass from member 25 through pipe 26, pipe 29 and pipe 34 to cross coupling 11 from whence the air passes downwardly through pipe 9 to the interior of the liquid compartment 3. Compartment 3 may be previously supplied with a quantity of combustible liquid, such as gasoline, pentane, hexane, benzol, alcohols, or in general any combustible liquid which when suitably admixed with air may produce a combustible gas. As air is introduced into liquid compartment 3 the pressure within said compartment may raise, thereby passing liquid upwardly through pipe 10, pipe 14, tubing 18 and into vaporizer 19. When the pressure within liquid compartment 3 reaches a predetermined maximum, that is, the maximum for which the member 25 may be set, said member operates to permit communciation between pipe 24 and pipe 27, thereby permitting air under pressure to pass from blower 22 to conduit 42.

The liquid passing through pipe 18 from liquid compartment 3 may be discharged within container 36 and upon contacting the bottom of said container may be heated and vaporized. The vapors may be induced upwardly through slot 43 into conduit 42 wherein the same are admixed with the air under pressure passing through pipe 35. Said admixed vapor and air may pass through pipe 44 into gas compartment 4.

Referring particularly to Fig. 4, a schematic diagram of the electrical connections of the various instrumentalities utilized in connection with my invention are shown, wherein the terminals *a* and *b* may indicate any suitable source of electricity. As a feature of my invention, the heating element 39 disposed in the vaporizer 19 may be divided into a plurality of sections. One section of said heating element may be energized at all times, whereas the remaining sections thereof may be energized only when gas is being generated. To accomplish this end, I may con-

nect terminal *b* by means of lead 50 to section 39' of the heating element 39, the opposite end of said heating element being connected to return lead 51, which in turn may be connected to terminal *a*. In this manner current from said external source is passed directly through heating element 39', which in the preferred embodiment of my invention may comprise the inner portion of heating element 39 as disposed in the insulating material 38.

It can readily be seen that by the provision of heating element 39' and the maintenance of said heating element in energized condition the temperature of the vaporizer may be maintained at a desired elevated degree. It can also be seen that when blower 22 is in operation as liquid passes from the liquid compartment 3 to the vaporizer 19, said liquid will tend to cool the vaporizer. To compensate for this cooling action I may provide means for the energization of the second portion 39'' of the heating element 39, which energization may take place simultaneously with the operation of the blower 22, and hence simultaneously with the introduction of liquid into the vaporizer. The portion 39'' of the heating element which may be energized intermittently, as hereinbefore described, may occupy the outer portion of the element 39 disposed within the insulating material 38. That portion of the heating element 39'' which is intermittently heated may be connected at one end by means of lead 51 to the terminal *a*. The opposite end of said heating element may be connected by means of lead 52 to mercoid switch 49, the opposite terminal of which may be connected to the electrical supply terminal b. Motor 23 which may drive blower 22 may be connected across leads 51 and 52 and may also be controlled by mercoid switch 49. In addition, the solenoid 15' of valve 15 may be connected across said leads and may also be controlled by mercoid switch or pressure-operated switch 49.

The arrangement is such that when the gas pressure within compartment 4 reaches a predetermined maximum, and hence the pressure within pipe 46 reaches said maximum, mercoid switch 49 may act to automatically disconnect motor 23, solenoid 15' and heating element 39'' simultaneously. When the pressure within gas compartment 4 reaches a predetermined minimum mercoid switch 49 may act to energize motor 23, solenoid 15' and heating element 39''. In this manner air under pressure may be delivered to liquid compartment 3 passing a quantity of said liquid from said compartment through valve 15, which may have been opened by the energization of solenoid 15' to vaporizer 19, the entire heating element of which has been energized. In this manner the pressure within gas compartment 4 may be raised by the introduction of the mixed air and vapor from the vaporizer 19, and when said pressure reaches a predetermined maximum the mercoid switch 49 may act to stop the blower 22, close the valve 15 and de-energize the heating element 39''. By energizing the element 39'' simultaneously with the introduction of liquid into the vaporizer 19, the temperature of said vaporizer may be maintained substantially constant. Also, by maintaining the element 39' in heated condition the initially introduced liquid from pipe 18 will impinge upon a heated surface immediately upon its introduction into the vaporizer 19 and will be vaporized. If this were not the case liquid would be introduced to said cold vaporizer and would tend to accumulate there, and hence the generation of gas would lag behind the operation of the blower.

As a feature of my invention, I may provide a vaporizer which may have a substantial heated surface area which may facilitate the immediate removal of vapor as the same is formed and will eliminate any back pressure due to said change of state of the liquid to a vapor and the expansion caused thereby. It can readily be seen that if the vapors arising from the heated surface within the vaporizer were hindered, for instance, by impinging a liquid upon a small heated area, to immediately leave said surface when they reached the vapor state, that the capacity of the device would be seriously limited.

As another feature of my invention, by the provision of the member 25 the pressure imparted to the liquid passing through pipe 10 and into vaporizer 19 after the initial stages of operation will be substantially constant, and a sufficient time lag exists between the passage of air to the liquid compartment and the passage of air to the vaporizer to permit the liquid to be present at the vaporizer when the air is introduced thereto. If this were not the case and air was initially simultaneously passed from the liquid compartment and the vaporizer, a substantial quantity of air may be passed into the gas compartment 4 before any liquid would be introduced to the vaporizer, and hence a diluted gas would result.

As an example of operating conditions, mercoid switch 49 may be adjusted to operate when the pressure within chamber 4 reaches a predetermined maximum, say approximately four or five pounds per square inch, more or less, to shut off motor 23, de-energize solenoid 15' and element 39''. It may also be set to connect motor 23, solenoid 15' and element 39'' into circuit when the gas pressure reaches a predetermined minimum, say, for instance, one and one-half to two pounds per square inch, more or less. Inasmuch as the "dew-point", or the temperature at which liquid entrained in a gas separates therefrom, is lower at lower pressures, it can be seen that the ideal pressure to be maintained in the gas compartment will be determined by the average climatic temperatures encountered where my invention may be used.

Since the quantity of combustible liquid admixed with a predetermined quantity of air is a determining factor in the production of a gas of constant calorific value, and that the quantity of liquid is in turn a function of the pressure within the liquid compartment 3, it is apparent that relatively constant pressure within said compartment is desirable and may be maintained by the provision of the relief valve 25. The pressure at which the liquid compartment is maintained, that is, the pressure at which the relief valve 25 is set, is dependent upon various factors including the vapor pressure of the particular combustible liquid used, the desired B. t. u. content of the resultant gas, the type of blower, that is, whether of the rotary type or of the compressor type, and other factors among which may be mentioned the sensitivity of the relief valve.

When pentane is used as the combustible liquid, heating element 39 may be so designed as to maintain the bottom of the vaporizer, when no liquid passes thereto, at a temperature of about 125° F., more or less, and when liquid passes thereto additional heat may be imparted to said vaporizer by the energization of element 39'' to

maintain said vaporizer at approximately the same temperature. However, it is to be understood that the temperature at which the vaporizer 19 is to be maintained will be dependent upon the vaporizing temperature of the particular combustible liquid used.

It is to be understood, of course, that the herein mentioned constants affecting operating conditions, are given for purposes of illustration and are not intended to limit my invention.

For purposes of additionally controlling the passage of liquid from the compartment 3 to the vaporizer 19, a control valve 17' may be interposed in the pipe 17. Control valve 17' may take the form of a hand operated valve or, if desired, may be of the automatic type, such as a pressure regulating valve of any of the varieties now familiar to the art.

I claim as my invention:

1. In combination, a combustible gas generating device comprising a chamber for combustible liquid, means for passing air under pressure to said chamber, a vaporizer, means for passing liquid from said chamber to said vaporizer, means for heating said vaporizer, and means for passing air under pressure to said vaporizer when the pressure within said liquid compartment reaches a predetermined maximum.

2. In combination, a combustible gas generating device comprising a chamber for combustible liquid, means for passing air under pressure to said chamber, a vaporizer, means for passing liquid from said chamber to said vaporizer, means for heating said vaporizer comprising an electrical heating element divided into a plurality of sections, one section being energized substantially simultaneously with the introduction of liquid to said vaporizer, and means for passing air under pressure to said vaporizing zone when the pressure within said liquid compartment reaches a predetermined maximum.

3. In combination, a combustible gas generating device comprising a chamber for combustible liquid, means for passing air under pressure to said chamber, a vaporizer comprising a receptacle having a bottom of relatively enlarged area, means for passing liquid from said chamber to said vaporizer, means for heating the bottom of said vaporizer, and means for passing air under pressure to said vaporizer when the pressure within said liquid compartment reaches a predetermined maximum.

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