Feb. 4, 1930. **J. A. DIENNER** **1,745,568**

FUEL FEED SYSTEM

Filed Feb. 11, 1924 2 Sheets-Sheet 1

Fig. 1.

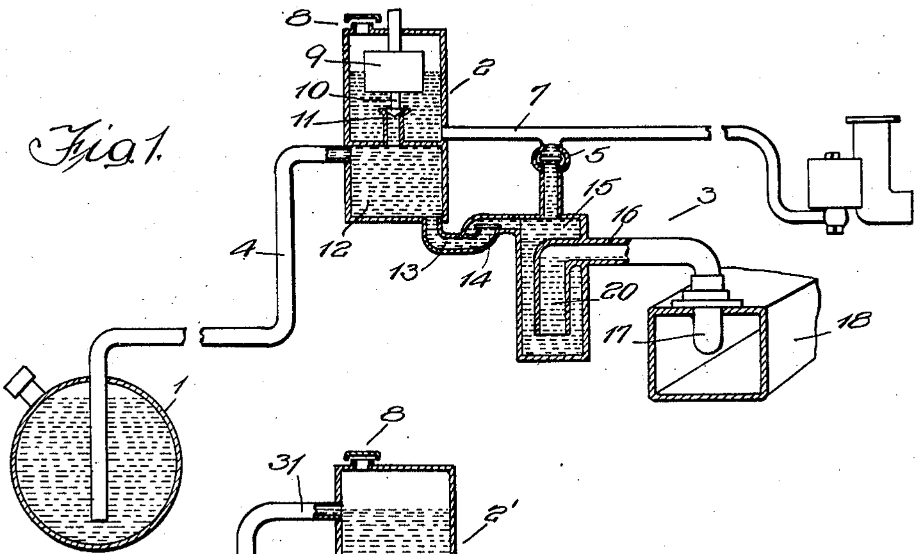


Fig. 2.

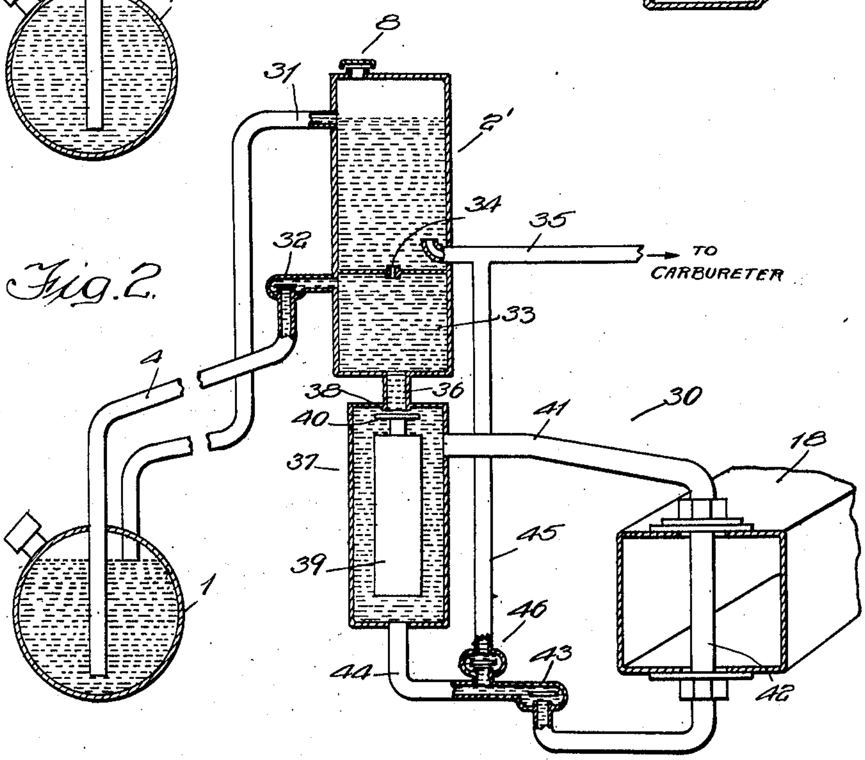
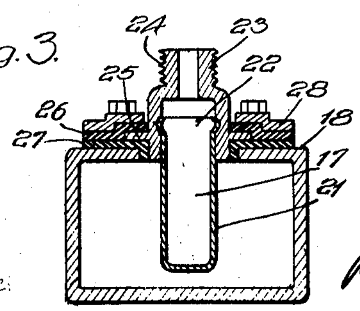


Fig. 3.

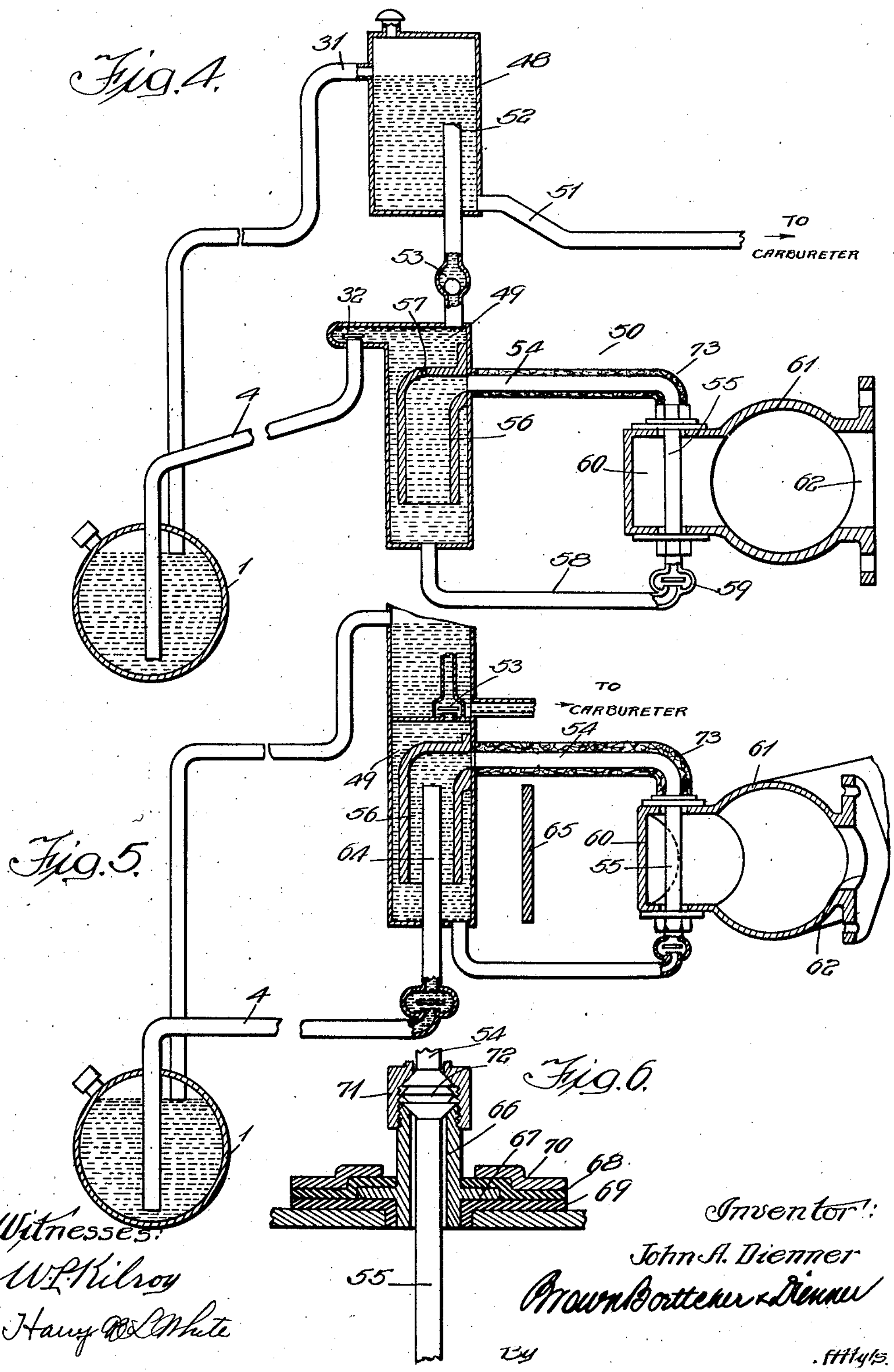


Witnesses:
W. L. Kilroy
Harry R. L. White

Inventor:
John A. Dienner
By Brown, Boettcher & Dienner
Att'ys

FUEL FEED SYSTEM

Filed Feb. 11, 1924 2 Sheets-Sheet 2



Witnesses:
W. L. Kilroy
Harry L. White

Inventor:
John A. Dienner
By Brown, Boettcher & Dienner
Attys.

Patented Feb. 4, 1930 **1,745,568**

UNITED STATES PATENT OFFICE

JOHN A. DIENNER, OF CHICAGO, ILLINOIS, ASSIGNOR TO STROMBERG MOTOR DEVICES COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS

FUEL-FEED SYSTEM

Application filed February 11, 1924. Serial No. 691,912.

My invention relates to fuel feed systems of the class first disclosed in my copending application, Serial No. 511,877, filed October 31, 1921, which has resulted in Patent No. 1,694,911, granted December 11, 1928.

While the system of my invention is particularly applicable to the feeding of liquid fuel from a low level tank to a carbureter of an engine, it is to be understood that the invention has other uses and applications which are contemplated within the scope of the appended claims.

In supplying liquid fuel to an internal combustion engine particularly of the automobile type, it is to be noted that the demands of the engine cover a wide range of variations. That is to say, assume that the engine has speeds of from 200 to 2,000 revolutions per minute it will be seen at once that there is a wide range of variation of the heat which is available to operate the pumping device. In a system of this class which operates on the heat of the engine and which is designed to secure a general correspondence between the amount of fuel employed and the amount of fuel pumped, it is desirable that the device have a wide range of action.

It is highly important that the system be put into operation as promptly as possible after the starting of the engine, and it is desirable that the system maintain a reserve for the carbureter for starting purposes and for warming up the engine, and that the system should also maintain a supply of liquid for priming the pump.

In order that the device may not be overpowered by excess heat at high engine speeds and in order that the device may operate satisfactorily with a relatively low supply of heat at lower engine speed, it is desirable that means be provided for making strokes of the pump in an orderly progression in substantial accordance with the heat input.

In my original device, as disclosed in the above mentioned patent, I have employed a float valve for compelling the orderly making of strokes. A device of this character is in reality a small heat engine working upon a working fluid which is the fuel for the engine. Since the device is in reality a heat engine it must progress according to a regular thermo-dynamic cycle and this cycle must be under regular control.

In order to speed up the action of initial vaporization for starting the pumping action, I provide first a separate vapor forming chamber arranged to heat the body of liquid to the point of forming vapor as rapidly as possible.

This vapor forming chamber is separated from the working chamber which is adapted to receive vapor from the vaporizing chamber and to expel liquid therefrom and I provide an absorber of the heat of the vapor for condensing the vapor so as to permit refilling of the working chamber with liquid.

I convey the vapor formed in the vaporizing chamber to a closed trap or working chamber for expelling the contents to cause a liquid discharge from the pumping mechanism. The vapor may then be expelled from the working chamber or liquid may be injected into the chamber in order to condense the vapor for filling the chamber.

These actions are carried out in a regular cycle. Since the vaporizing chamber is separate from the working chamber and the condensing chamber is arranged to maintain the liquid out of the working chamber, it makes no difference how hot the heating or vaporizing chamber gets nor how cold the condensing chamber gets so long as the required difference in temperature is maintained suitable for working the device.

In order to acquaint those skilled in the art with the method of constructing and operating my invention I shall now describe a specific embodiment of the same in connection with the accompanying drawings.

Figure 1 is a diagram of a system embodying my invention, emp..ying as the vaporizing chamber, a closed end tube;

Fig. 2 is a modification in which the heating chamber is a pipe, both ends of which communicate with the working chamber. In this construction the working chamber is normally separated from the condensing liquid chamber by a float valve;

Fig. 3 is a sectional view through the vaporizing chamber shown in Fig. 1;

Fig. 4 is a diagrammatic layout of a system similar to that shown in Fig. 1 employing, however, a vertical pipe in contact with the exhaust gases for the vaporizing chamber;

Fig. 5 is a diagram of a system similar to Fig. 4 in which, however, the liquid from the main tank is injected into the working chamber; and

Fig. 6 is a cross sectional view through the working chamber showing the manner of mounting the same upon the exhaust manifold.

As I have shown in Fig. 1, the main tank 1 for liquid fuel is placed at a lower level than the reservoir 2 and the pumping device 3. The pumping device 3 takes liquid from the low level tank 1 through the suction pipe 4 and discharges the same into the reservoir 2 through a check valve 5 which connects directly with the pipe or conduit 7, this pipe or conduit communicating with the bottom of the reservoir 2 and leading to the carbureter as indicated on the diagram. The reservoir 2 is open at its top as indicated at the opening 8 to atmosphere, and it contains a float 9 governing a valve 10, which valve seats at the top of a standpipe 11. This standpipe 11 comprises first a communication between the reservoir 2 and the trap 12, which communication is opened only when liquid in the reservoir 2 reaches a high level which raises the float valve 9—10 from the valve seat in the top of the standpipe 11.

This standpipe also tends to trap sufficient fuel below the same in the reservoir 2 to supply the carbureter with a starting charge for warming up the engine to the point where further fuel will be pumped. The height of the standpipe 11 may be made any desired value within limits, for accomplishing this purpose.

The suction pipe 4 leads from the bottom of the main tank 1 to the top of the trap 12. This trap is formed in the intake pipe for trapping sufficient liquid to invariably prime the pumping device 3 even if the automobile should stand for a considerable period of time unused.

The bottom of the trap 12 communicates through a conduit 13 and check valve 14 with chamber 15, which chamber 15 is termed herein, the condensing liquid chamber. It is so designated because it contains the liquid which is employed in condensing the vapor from the working chamber. The working chamber in this case comprises an inverted U-shaped passageway 16 for trapping vapor and for expelling liquid. At its outer end this U-shaped passageway 16 terminates in a vaporizing chamber 17, in this case shown as a closed end tube, exposed to the gases of the exhaust pipe 18. The opposite end of the U-shaped conduit 16 terminates in this case in an enlarged end 20, the lower end of which is open to the chamber 15 so that it communicates with the condensing liquid in said chamber 15.

It is to be noted that the enlargement 20 comprises the major part of the working chamber and the function of the same is to trap vapors at its upper end and to expel liquid at its lower end until the working chamber is substantially empty of liquid whereupon condensation of the vapor occurs with a contraction of the vapor and a suction of further liquid through the trap 12.

The operation of this system is as follows:

Liquid from the reservoir 2 passes out through the conduit 7 through the carbureter, supplying the same with liquid. Now assuming that the engine is cold, the engine may be started with the liquid trapped in the reservoir 2 below the top of the standpipe 11, or, in fact, any amount of the liquid which may be in said reservoir. The heat of the exhaust gases strikes the vaporizing chamber 17 which consists of a brass tube 21 having thin walls and adapted to absorb rapidly the heat from the exhaust gases. As vapor is formed in the vaporizing chamber 17 it rises in the conduit 16 and is trapped in the top of the working chamber, expelling liquid down the lower part of the working chamber 20 until the liquid is substantially discharged therefrom, whereupon the vapor rises under the end of said working chamber 20 over into the condensing liquid chamber 15. As the liquid is depressed in the working chamber 20 it is expelled out past the check valve 5 into the conduit 7, such part as is required by the carbureter passing down to said carbureter and the remainder being driven over and up into the reservoir 2.

As soon as the vapor passes under the end of the working chamber 20 out into the liquid condensing chamber 15 the pressure is suddenly relieved and the same time the liquid condenses the vapor causing a rapid shrinkage with the result that a suction is created in said chamber 15 and liquid is therefore drawn from the main tank 1 through the suction pipe 4 through the trap 12 and past the check valve 14. When the liquid begins to condense the vapor more rapidly than the vapor is formed the liquid will rise in the working chamber until the rate of vapor formation again exceeds the entering rate of liquid whereupon another expulsion stroke will occur. Whenever the vaporizing chamber 17 becomes empty of liquid it will cease to form further vapor with the result that the rate of condensation will exceed the rate of vapor formation and liquid will rise in the working chamber until it runs over the top part of the same, and by gravity runs into the vaporizing chamber 17, whereupon successive strokes will again occur.

It is to be noted that the excess of liquid pumped by the pumping device 3 results merely in a circulation of the liquid up into the reservoir 2 and when sufficient liquid has been stored in the reservoir 2 to lift the float valve 9—10 the weight of the column of liquid in the pipe 4 will tend to withdraw liquid and bring the float valve 10 back upon its seat.

Now it will be noted that the system as shown in Fig. 1 provides, first a starting charge in the reservoir 2 for supplying the carbureter. Furthermore the reservoir provides liquid for sealing the valve 10 and if this valve should leak and permit the contents above the valve to pass down into the trap 12, air will then follow and break the partial vacuum at the top of the trap 12 permitting the pipe 4 to empty but to retain a charge in the trap 12 for keeping the pumping device 3 full of liquid.

Since the two check valves 5 and 14 are in series it is unlikely that both of these check valves will leak and consequently the starting charge for the carbureter will be maintained.

In Fig. 3 I have shown the vaporizing chamber in section. This comprises a small closed end brass tube 21, the upper end of which is expanded as indicated at 22, into a groove formed in the fitting 23. This fitting 23 has a thread 24 for the connection of the pipe or conduit 16 and it has a flange 25 which is held between layers of insulating material 26 and 27 as by means of the clamping ring 28. In this manner the transmission of heat either to or from said fitting 23 and consequently the liquid in the vaporizing chamber 17 is prevented. This is for the purpose of permitting the vaporizing chamber to heat its liquid rapidly without giving up heat to the exhaust pipe 18 and also to prevent heat from the exhaust pipe 18 being transmitted to the vaporizing chamber and to the liquid therein when the exhaust pipe is hot.

In Fig. 2 I have shown a modified system in which the same arrangement of a separate working chamber and vaporizing chamber and liquid condensing chamber is provided. In this case the reservoir 2′ has an overflow pipe 31 leading back to the main supply chamber 1 for returning liquid when the reservoir 2′ is full. The suction pipe 4 leads past the check valve 32 into the liquid trap 33, which in this case is also the condensing liquid chamber. The trap 33 in this case is formed as a continuation of the reservoir 2′, the two chambers being separated by a wall which contains a small leakage port 34 which leakage port may be formed directly in said wall or may be placed in a standpipe leading up a predetermined distance in the reservoir 2′. A pipe 35 leads to the carbureter from a point adjacent the bottom of the reservoir 2′. The condensing liquid chamber and trap 33 leads by way of a short pipe connection 36 to the top of the working chamber 37, this working chamber having a valve seat 38 at the point where the connection 36 enters said chamber 37. A float 39 bearing a valve 40 at its upper end is contained in said working chamber 37 and when the liquid has substantially filled the working chamber 37 the valve 40 closes against the seat 38 and is held there by the float 39. A pipe 41 leads from the upper end of the working chamber 37 to the vertical pipe 42, which in this case forms the heating chamber. The lower end of the vertical pipe 42 which forms a vaporizing chamber, communicates past check valve 43 with the bottom of a working chamber 37 through the pipe 44. A branch from the pipe 44 shown at 45 leads through check valve 46 to the reservoir 2′ through the pipe 35. It may be led into the reservoir 2′ independent of the pipe 35. The branch connection for the pipe 45 lies on the pipe 44 between the check valve 43 and the working chamber 37.

The operation of this device is as follows:

Assuming that the system is full of liquid, and it may be so filled by means of the filling cap 8, the engine may be started from the charge which is trapped in the reservoir 2′. Upon the heated gas striking the pipe 42 vapor is formed therein and this rises to the pipe 41 and then to the upper part of the working chamber 37 gradually depressing the liquid therein and forcing the same up to the connection 45 until the liquid in the working chamber 37 no longer supports the float 38. It is to be noted that liquid may escape from the heating chamber 42 in both directions, but can enter the same only from the top connection 41 as here shown. This tends to give a longer time period to the strokes but if desired the valve 43 may be dispensed with and then the rate of making strokes will tend to be more rapid and less orderly. When the float 39 loses its support in the liquid it opens valve 40 and liquid from said trap 33 comes in contact with the vapor and the result is a partial condensation of the vapor in the working chamber 37 with a contraction of the contents thereof, the result being that liquid is drawn by suction from the trap 33 and up through the pipe 44 to replace the same. Liquid may also be drawn through the by-pass or leakage port 34 but this is relatively restricted and hence the major part of the liquid will come up through the suction pipe 4. So long as the suction persists in the working chamber 37 due to this condensation, liquid will flow into said working chamber 37 even though the valve 40 tends to close under the influence of the float 39. The result is that condensation continues until liquid runs in the pipe 41 over into the pipe 42 where vaporization again occurs and a succeeding stroke is made by lowering of the liquid level in the chamber 37.

It is to be noted that in connection with both Figs. 1 and 2 the system may be put into working condition by pouring a suitable charge into the reservoir 2 or 2′ until the same is full.

It is to be noted that in a system of Fig. 1 the check valve 14 in the suction line is posterior to the trap 12 while in the system of Fig. 2 the check valve 32 is anterior to the trap 33.

It is also to be noted in connection with Fig. 2 that the check valve 43 is specifically employed for preventing condensing where the heating of the chamber 42 is relatively slow, but as heretofore explained, the check valve 43 may be dispensed with if desired.

In the system shown in Fig. 4 the reservoir 48 is placed above the trap 49, which trap 49 also serves as the condensing liquid chamber. The reservoir 48 is adapted to retain a charge for the carbureter, which carbureter is fed by way of the pipe 51 leading from the bottom of said reservoir 48. The discharge pipe into the reservoir 48 terminates as indicated at 52 a substantial distance below the top of the overflow pipe 31 so that there is a body of liquid above the top of the pipe 52 for normally sealing the check valve 53 in said discharge pipe, but even if the liquid above the top of the discharge pipe 52 should leak past the valve 53, air leaking in and past the valve 53 would enter the top of the trap 49 and then be stopped by the check valve 32, or if it leaks the air would then simply permit liquid in the suction pipe 4 to drop without disturbing the charge for the carbureter or for priming the pumping device 50. This pumping device 50 comprises the pipe 54 which connects the vertical pipe 55, which pipe 55 is the vaporizing chamber, with the working chamber 56. The working chamber, in this case, has at its top a small bleeder hole 57 to permit air or gas to pass out of the same when the device is full of liquid.

The bottom of the trap and condensing liquid chamber 49 communicates by way of a pipe 58 through check valve 59 with the bottom of a vaporizing pipe 55.

This vaporizing pipe 55 is placed in a pocket 60 in the outside of the exhaust pipe 61 and opposite the port 62 where an intermediate cylinder or pair of cylinders discharges its gases into the body of the exhaust pipe 61. That is to say in a four cylinder engine, cylinders 2 and 3 discharge their exhaust through the passageway or port 62 into the main body of the exhaust pipe 61 and opposite said port or passageway 62 is the pocket 60 containing the heating pipe or chamber 55. During a relatively low speed of the engine the amount of gases coming from cylinder 1 is not so great as to disturb the inflow of gases from the port 62 directly into the pocket 60, but if a substantial amount of gases is being discharged from cylinder No. 1 or from the cylinders in advance of the port 62, then there is a tendency to deflect the gases entering the port 62 from the pocket 60 and relatively less heat strikes said heating pipe 55.

It is therefore possible to have a less effective transfer of heat per stroke for higher engine speed than for lower engine speed; or to put it another way, when the volume of gas is passing through the exhaust pipe 61 is great, then the rate of heat transfer to the pipe 55 is not so great as when the volume is less. The desired result is that there is a greater effectiveness of heat transfer at low speed than at high speed, so that the device will not pump too great an excess of fuel at high speed when it is set to pump at a relatively rapid rate at low speed.

The operation of the system, further, is substantially the same as described in connection with Figs. 1 and 2 in the main features of operation; namely the first formation of vapor in the vaporizing chamber 55, which then passes over through the pipe 54 into the top of the working chamber 56, expelling the liquid out of the bottom and driving liquid up through the discharge pipe 52 past check valve 53 into the reservoir 48. Upon discharge of vapor from the working chamber 56 the vapor tends to rise and expand, but is quickly condensed by the liquid in said condensing liquid chamber 49 whereupon a shrinkage of the contents of the working chamber 56 rapidly occurs and a suction stroke is made, raising liquid through the suction pipe 4. When the condensing action begins, that is when the pressure in the chamber 55 and the working chamber 56 drops, liquid can then enter the vaporizing chamber 55 through the check valve 59. This check valve tends to remain closed so long as the pressure in the vaporizing chamber 55 increases rapidly enough to expel liquid from the working chamber 56. The check valve 59 is not absolutely essential since there is no tendency for a convection current to be set up due to the inverted U-shape of the working chamber and its connected vaporizing chamber, but the tendency of the valve 59 is to hold a charge of liquid in the vaporizing chamber 55 so that continuous vaporization can occur until the working chamber 56 is substantially emptied and vapor discharged therefrom before further liquid will be injected into said vaporizing pipe 55.

The system of Fig. 5 is substantially the same as that shown in Fig. 4 with the exception that here the suction pipe 4 has an extension 64 which enters the working chamber 56 so that the shrinkage of the contents of the working chamber results in the injection of relatively cold liquid directly into the working chamber. That is to say instead of discharging the vapor into the condensing liquid chamber and then depending upon the entry of the same liquid into the working chamber to condense the vapor, a different charge of liquid is drawn into said working chamber. The pipe 64 need not be led directly up through the bottom of the working chamber 56; it may lead up laterally and discharge into the top of the working chamber if desired. The other parts of the system are the same as those described in connection with Fig. 4.

I have shown a heat insulating device such as a piece of asbestos board or the like 65 interposed between the exhaust manifold and the condensing liquid trap 49.

It is to be understood that the condensing liquid is to be maintained at as low a temperature as it is possible to do so, in order that easy transfer of heat from the vapor to the liquid may be made. It is also advisable to insulate the pipe which connects the vaporizing chamber with the working chamber; that is the top of the vapor trap, so as to prevent loss of heat in condensation.

I have shown in Fig. 6 now the pipe 55 may be mounted in a fitting 66 as by means of the flange 67 lying between the layers of insulation 68 and 69 and held in place by clamping ring 70. The upper end of the pipe 55 is flared out and is held by means of a coupling 71 in connection with the pipe 54 by means of a double cone fitting 72.

The heat insulating material for the pipe 54 is indicated at 73 on Figs. 4 and 5.

I do not intend to be limited to the details shown or described.

I claim:

1. In combination, a low level source of liquid supply, a source of demand, a chamber for generating liquid vapor, a pumping chamber separate from and communicating with said vapor generating chamber, a reservoir for receiving liquid from the pumping chamber, a suction connection between the pumping chamber and the low level source of liquid supply, means for heating the vapor generating chamber independently of the pumping chamber, and a trap for liquid in the suction connection, said trap being disposed above the pumping chamber and the vaporizing chamber to feed said chambers by gravity.

2. In combination, a low level source of liquid supply, a source of demand, a chamber for generating liquid vapor, a pumping chamber separate from and communicating with said vapor generating chamber, a reservoir for receiving liquid from the pumping chamber and for supplying the source of demand, a suction connection between the pumping chamber and the low level source of liquid supply, means for heating the vapor generating chamber independently of the pumping chamber, and a condensing chamber communicating at its lower end with the pumping chamber and having means for exposing a relatively large area of liquid to the vapor to condense the same rapidly, said condensing chamber embracing the pumping chamber.

3. In combination, a low level source of liquid supply, a source of demand, a condensing chamber, a suction connection from the condensing chamber to the low level source of liquid supply, a liquid trap in said suction connection disposed above the condensing chamber, a reservoir connected to the condensing chamber and adapted to receive liquid fuel discharged therefrom, a connection from the reservoir to the source of demand, an inverted double-legged U-shaped passageway, one leg thereof being disposed in the condensing chamber and forming a working chamber, and the other leg disposed externally of said condensing chamber and forming a vapor generating chamber, and means for heating said vapor generating chamber independently of said working chamber.

4. In combination, a low level source of liquid supply, a source of demand, a vaporizing chamber, a working chamber connected to said vaporizing chamber, a condensing chamber having open communication with the bottom of the working chamber and being disposed therein, a suction connection from the condensing chamber to the source of liquid supply, a reservoir connected to the source of demand, a discharge connection from the condensing chamber to the reservoir, and a trap in the suction connection between the condensing chamber and the source of liquid supply.

5. In combination, means for conveying a flow of heated gases, said gases having different rates of flow, an engine having an exhaust outlet discharging into said conveying means, and a heat operated pumping device exposed to the heat of the exhaust gases and disposed out of the main path of heated gas flow through said conveying means, said heat operated pumping device being disposed substantially in alignment with the path of discharge of exhaust gases from the engine into said conveying means.

6. In combination, means for conveying a flow of heated gases, said gases having different rates of flow, a heat operated pumping device exposed to the heat of said gases, means for rendering said pumping device less responsive for high rates of flow than for low rates of flow of said gases through said conveying means, said means comprising a source of heated gas supply discharging lat-

erally into the path of heated gas flow through said conveying means and in a direction across said flow, and a heat sensitive device forming a part of said heat operated pumping device and disposed laterally out of the path of the heated gas flow through said conveying means on the opposite side thereof and in alinement with the discharge of heated gases into the flow of gases through said conveying means.

In witness whereof, I hereunto subscribe my name this 8th day of February, 1924.

JOHN A. DIENNER.