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PNEUMATICALLY OPERATED FUEL SUPPLY SYSTEM FOR AUTOMOBILES

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Fig. 1.

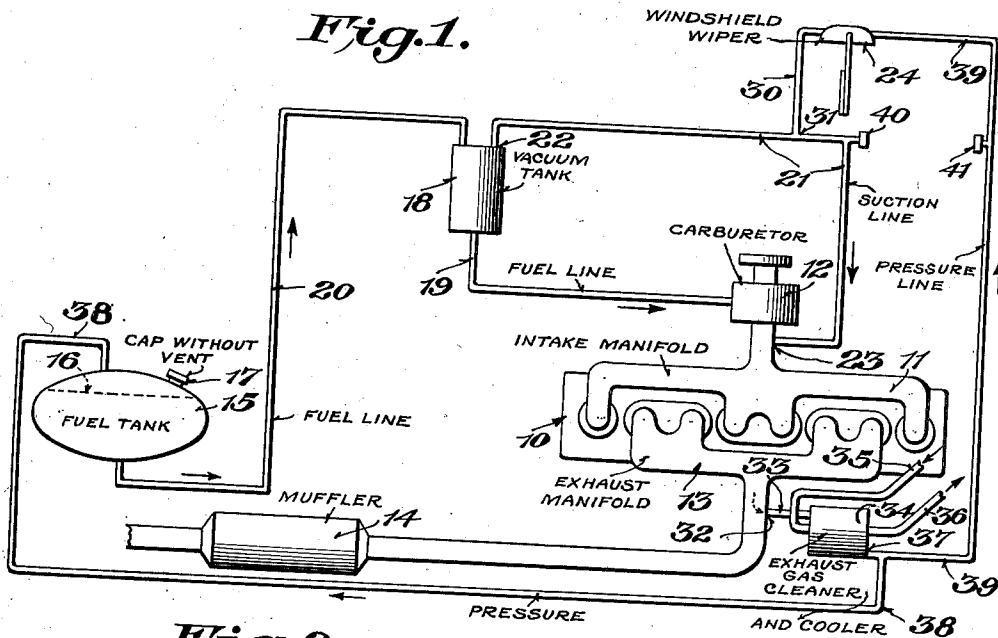
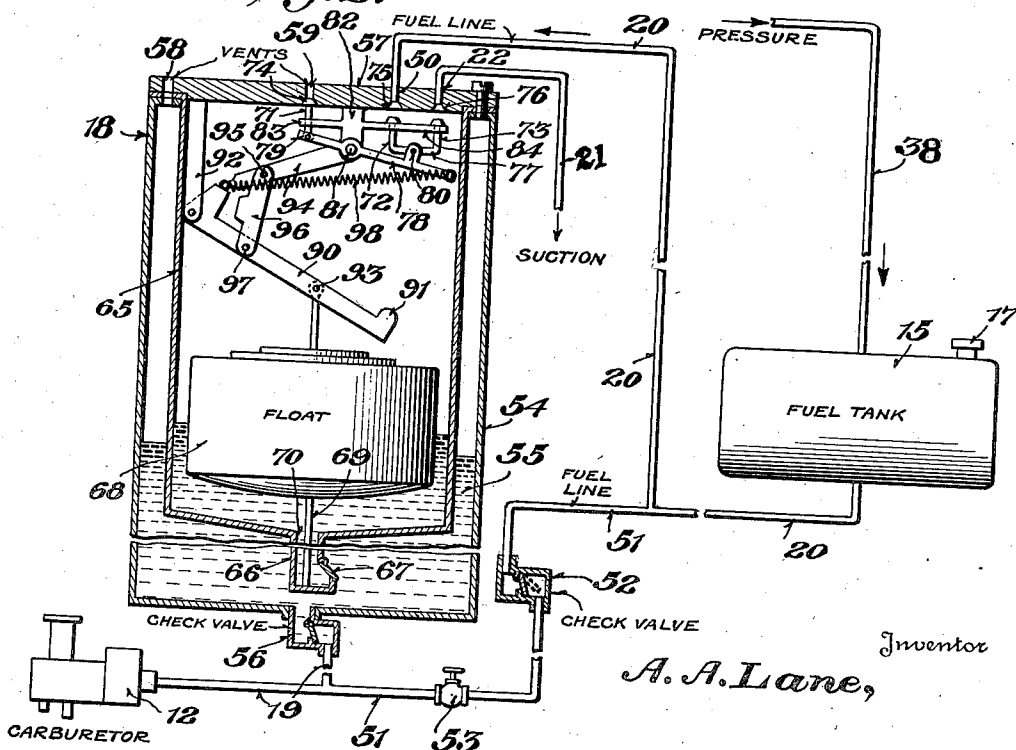


Fig. 2.



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PNEUMATICALLY OPERATED FUEL SUPPLY
SYSTEM FOR AUTOMOBILES

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velopment Company, Pittsburgh, Pa., a corpo-
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3 Claims. (Cl. 158—36.5)

This invention relates to pneumatically oper-
ated fuel supply systems for automobiles; and
it comprises, in an automobile having an engine
with the usual carburetor, intake conduit and
open exhaust conduit, a fuel system comprising a
main fuel tank, an open pressure connection be-
tween the exhaust conduit and the main tank,
and an independent suction operable fuel sup-
ply device operable by engine intake suction and
arranged to feed fuel from the main tank to the
carburetor, whereby adequate fuel feed is main-
tained under all engine operating conditions; all
as more fully hereinafter set forth and as claimed.

In automobiles the main fuel supply tank is in
general at a lower level than the carburetor, and
it is usual to provide a suction operable device of
some sort for drawing fuel from the tank and
supplying it to the carburetor. Ordinarily the
suction device takes the form of a "vacuum tank";
a float-controlled tank apparatus mounted above
the engine in suction communication with the
intake manifold and adapted to draw fuel from
the main tank and supply it under gravity head
to the carburetor. It is, moreover, usual to em-
ploy intake manifold suction for operating other
accessories besides the fuel supply, such as wind-
shield wipers, horns, clutches and servo brakes;
said accessories being in more or less general use
and usually having mechanical suction responsive
means such as pistons, diaphragms or bellows.

In suction systems of this sort the intake man-
ifold is tapped at some point between the cylin-
ders and the throttle. The suction in this re-
gion is high when the throttle is closed or nearly
closed, but drops rapidly at larger throttle open-
ings. When the throttle is wide open, as in high
speed work or under heavy pulling, there is in-
sufficient suction for proper operation of the fuel
supply device. Vacuum tanks are commonly
equipped with reserve storage capacity for main-
taining a fuel supply to the carburetor during
short intervals of wide open throttle operation;
but sometimes this expedient is inadequate.

The most important of the suction-operated
systems mentioned is of course the fuel supply
system. In view of the serious disadvantages in-
herent in the vacuum tank system described, pres-
sure feed systems were developed. In these sys-
tems the main fuel tank is made pressure tight,
and air or gas under pressure is supplied to this
tank from an air compressor, or direct from a
cylinder of the engine through a check valve.
These systems require a manually operable air-
compressor for establishing an initial pressure
before starting up.

This type of fuel feed system has several ad-
vantages, among them being constant fuel sup-
ply at all speeds, elimination of evaporation in
the main tank (the tank being always closed air-
tight) and elimination of vapor lock in the fuel
line. The advantages over vacuum systems are
particularly important in high speed work. Nev-
ertheless, this type of system is obsolescent; the
reason for this residing in its several serious inher-
ent disadvantages. In case of a leak in the sys-
tem such as a leaky carburetor float valve, then
when the car is left standing, the gasoline will
continue to leak until the air pressure in the tank
has dropped to the pressure outside. If the fuel
tank is only partly filled, the fuel tank may emp-
ty itself completely. In case of a collision, if
the gasoline tank is punctured, or the fuel line
broken, a stream of gasoline will burst forth un-
der pressure, which may result in serious fires.
A third objection to the straight pressure feed
system is the annoyance of having to establish
pressure in the gasoline tank by the use of a hand
pump before starting the car, which operation is
frequently forgotten, and the battery run down
in an ineffective effort to start without pressure
for fuel supply. Also, the cap in the main tank
must be kept perfectly tight, in order to con-
serve the limited amount of pressure developed by
the small engine compressor or by the single
engine cylinder.

The present invention is an improvement over
such systems. I provide a fuel supply device
adapted to be operable by suction, and to utilize
intake manifold suction in the usual way; but I
also utilize exhaust pressure. The fuel supply
device is modified to adapt it for pressure as
well as suction operation; and the exhaust man-
ifold of the engine is tapped as a source of op-
erating pressure. As stated, intake suction de-
creases with increasing throttle opening. Exhaust
pressure, however, increases with throttle open-
ing. Intake suction and exhaust pressure are
complementary, so to speak; the differential pres-
sure is fairly constant under all conditions. The
fuel supply system functions efficiently and equal-
ly well under all conditions and speeds. The
fuel supply device used is analogous to the ordi-
nary vacuum tank but with additional valve
means for preventing flooding of the vacuum
tank, and certain other additional valve means
in the fuel line. Appropriate cleaning and cool-
ing means are provided for the exhaust gases.

In the accompanying drawing showing one form
of a specific embodiment of my invention;

Fig. 1 is a diagram of a complete fuel supply system showing all suction and pressure connections, and

Fig. 2 shows the suction-pressure tank in detail and also serves to show a modification of the fuel supply system for permitting direct feed from the main tank to the carburetor under open-throttle conditions.

In the drawing, in which like reference characters indicate like parts throughout, the system is shown applied to an automobile having an engine 10 provided with the usual intake manifold 11 and carburetor 12 and the usual exhaust manifold 13 leading to muffler 14. The fuel supply system comprises a main fuel tank 15 adapted to hold a body of fuel 16 and in most cases located at the rear of the vehicle. The tank is provided with a solid (ventless) cap 17. A vacuum tank 18 is positioned above the carburetor, and is adapted to supply fuel thereto under gravity head through a pipe 19. The tank draws from the main fuel tank through a pipe 20. Suction to the vacuum tank is supplied through a suction line 21 attached to the vacuum tank as at 22 and to the intake manifold of the engine as at 23.

The system described thus far is analogous to ordinary automobile suction systems.

According to the invention I utilize the engine exhaust as a source of pressure, tapping the exhaust manifold as at 32 by pressure conduit 33. The exhaust may be tapped either on the manifold proper or at any other convenient point in the exhaust conduit. As shown, I provide a cleaner and cooler for the exhaust gases, this being indicated diagrammatically at 34. The cleaner may comprise a simple chamber adapted to allow dust, oil, etc. to be precipitated from the exhaust gases; or the chamber may be fitted with baffles to facilitate the precipitation. In any case the cleaner and cooler are in open communication with the exhaust manifold and with the pressure conduits, no check valves or the like being used, so that pressure in the fuel system is released immediately upon stopping the engine. In my system all parts are at atmospheric pressure when the engine is not running, hence there is no chance for aggravation of leakage. For cooling the hot gases I find it advantageous to provide heat exchange between the hot gases and the engine cooling water. The cooler may be of the surface cooler type, cooling water being circulated therethrough by the engine pump. Heat exchange means between the cooling water and the exhaust gases are conventionally shown as water connections 35, 36 in the cooling water circulation system, entering the cleaner and cooler as shown. Instead of cooling by water the exhaust gases may be cooled by air if appropriate heat exchange means are provided, advantageously mounted in front of the engine radiator and adapted to receive a strong flow of cool air. Cooling means are not essential as far as the fuel supply system is concerned, and may be omitted if the system comprises only the fuel supply. But when other accessories such as windshield wipers are connected into the system (as described post, it is desirable to cool the exhaust gases, to prevent scorching of paint, excess heat in the car, etc. due to passage of hot gases through the pressure lines.

The cleaner and cooler is adapted to supply cleaned and cooled gas under pressure through outlet 37. As shown, a branch pressure line 38

runs from outlet 37 to the top of the main fuel tank.

In operation, the engine being run at any speed, suction is developed in line 21 and pressure in line 37. Suction is applied to the vacuum tank 18 and pressure is applied to the main fuel tank. The net pressure differential is substantially constant whatever the speed and load conditions of the engine.

Fig. 2 illustrates the vacuum tank construction in detail; it also illustrates a modified fuel system adapted to allow fuel to be supplied to the carburetor direct from the main tank under open throttle conditions. As in Fig. 1, the system comprises a fuel tank 15 with pressure connection 38 and delivery line 20 leading to vacuum tank 18 and connected therewith as at 50. The vacuum tank is positioned above the fuel tank and the carburetor. The vacuum tank is adapted to deliver fuel to the carburetor 12 by gravity through 20 line 19. Conduits 19, 20 and 38 are shown as broken to indicate that the vacuum tank is installed at a level above the fuel tank and above the carburetor, as shown in Fig. 1. The system shown in Fig. 2 comprises in addition a branch fuel line 51 joining fuel lines 19 and 20 as shown and having a check valve 52 and a common gate valve 53 as shown. As will be explained, this branch fuel line is adapted under certain conditions to allow fuel to be supplied directly from the main fuel tank to the carburetor, bypassing the vacuum tank.

The vacuum tank comprises a supply tank or casing 54 adapted to contain a body of fuel 55 and provided at the bottom with a check valve 56 adapted to allow flow downward but not upward. The top of the tank is closed by a cover 57 having vents 58 and 59 for air and the connections 20 and 22 for fuel and suction respectively.

An inner vacuum well or chamber 65 is suspended from the top of the outer casing, as shown. This chamber is sealed off from communication with the fuel reservoir proper except through a lower outlet 66 controlled by a check valve 67 allowing flow from, but not to, the inner chamber.

Inside the vacuum chamber is a float 68 mounted on a rod 69 guided loosely in aperture 70 in the bottom portion of the chamber, as shown. The float rod is adapted to actuate a linkage of valves. As shown, three poppet valves, 71, 72 and 73 are adapted to cooperate with seat 74 in vent 59, seat 75 in fuel inlet 50 and seat 76 in suction connection 22, respectively. Valves 72 and 73 are yoked on a U-shaped member 77, as shown, and valve 71 and member 77 are pivotally attached as at 79 and 80 to a rocking bar 78 which is pivoted as at 81 to a support 82 fixed to the top cover and having laterally extending members 83 and 84 with orifices adapted to guide the poppet valves, as shown. A rocking bar 90 having an upturned end 91 is pivoted at one end to a bracket 92 fixed to the top cover and is pivoted as at 93 to the upper end of the float rod, as shown. A swinging arm 94 is pivoted as at 81 to the support 82. The arm is pivotally connected as at 95 to a link 96 which is pivoted as at 97 to rocking bar 90. A coil spring 98 connects arm 94 and bar 78, as shown.

The mechanical operation of the vacuum tank is as follows: The float is shown in lower position, poppet valve 71 being closed and poppet valves 72 and 73 being open. When the float rises, following a rise in level of liquid in the inner chamber, bar 90 will rise, raising link 96 and arm 94. No movement of the poppet valves takes place until 75

arm 94 rises sufficiently to lift the coil spring above pivot 81 (dead center), whereupon the spring snaps up and the upturned end 91 of bar 90 contacts with the end of rocking bar 78. Bar 78 is tipped upward, closing valves 72 and 73 and opening valve 71. Upon falling of the float the valves are snapped to the former position. The linkage and spring arrangement is for the purpose of providing quick and positive opening and closing of the valves.

The operation of the vacuum tank and the rest of the system is as follows: At low speeds movement of fuel is mainly or partially by intake suction. Assume valve 53 closed; this valve is only opened when it is desired to make use of the bypass system as will be described. The float is shown in Fig. 2 as in low position, the supply of fuel in the vacuum tank being low. Poppet valve 71 is closed; valves 72 and 73 are opened. The engine being running, fuel is drawn from the main tank through line 20 under intake suction (acting through line 22) and into the inner well 65. Check valve 67 being closed fuel cannot flow from the outer casing into the inner well. Fuel is supplied to the engine by gravity through line 19 running to the carburetor.

The main fuel tank is under exhaust pressure, and this pressure assists in moving fuel from the main tank to the vacuum tank. At higher speeds most of the fuel movement is performed by exhaust pressure.

The valve linkage is for the purpose of closing off admission of fuel to the vacuum tank when the tank is full and allowing fuel to flow from the inner well to the outer casing. As the inner well gradually fills with fuel under the influence of intake suction and exhaust pressure, the float rises, and as it reaches a level near the top, springs the valve 71 open and valves 72 and 73 closed. Open valve 71 allows air to flow into the tank, permitting fuel to flow therefrom. Valves 72 and 73 close off the fuel line and suction line respectively. The level of fuel in the inner well being higher than in the outer casing, fuel flows from the inner well to the outer casing through check valve 67. Valve 72 is advantageously made quite small in diameter, so that it will remain closed against pressures developed in the fuel line under exhaust pressure.

The valves remain in the position just described until the level of fuel in the vacuum tank drops below a certain point, whereupon the float serves to snap the valves back to the position shown in Fig. 2. The cycle of operation is repeated. Fuel is again drawn into the vacuum tank.

At high speeds, intake suction is low and exhaust pressure is high, exhaust pressure serving to do most of the operation of the fuel supply system. In Fig. 2 I have shown a bypass system which makes it possible to use exhaust pressure directly for forcing fuel from the main tank to the carburetor, bypassing the vacuum tank, when the engine running conditions are such that exhaust pressure is high. This system comprises check valve 56 in conduit 19, bypass conduit 51 and check valve 52. An ordinary gate valve 53 allows the bypass arrangement to be thrown in and out of action as desired. In operation using the bypass, at low engine speeds fuel is moved principally by intake suction and assisted by exhaust pressure in the manner described. Check valve 52 will be closed, as shown, as long as the pressure on one side of it due to the head in the vacuum tank is greater than the pressure on the other side

due to exhaust pressure on fuel in lines 20 and 51. When the engine is running under open throttle, however, a time comes when the exhaust pressure in the main fuel tank and conduits 20 and 51 exceeds the gravity head of the vacuum tank, whereupon check valve 52 is opened, taking the position shown in dotted lines in Fig. 2. Fuel then flows direct from the main fuel tank through conduits 20, 51 and 19, to the carburetor. Check valve 56 prevents fuel from being forced reversely into the vacuum tank through conduit 19. When exhaust pressure drops below the value equal to the hydrostatic head of the vacuum tank, check valve 52 closes and the vacuum tank comes into operation again. Valve 53 allows the bypass to be thrown in or out of operation. The bypass system is not essential, and may be omitted, check valves 52 and 56 and conduit 51 being omitted.

It is seen that in this system I have provided a new and useful improvement in automobile fuel supply systems, which makes possible uniform and constant operation thereof under all conditions, while adding little to the complication of the apparatus and without taking any power from the engine. The system has all the advantages of both vacuum systems and ordinary pressure systems, with the additional advantage over ordinary pressure systems that in the new system pressure automatically drops to zero when the engine is not running. The exhaust conduit being in open communication with the atmosphere, pressure can only exist in the exhaust conduit when the engine is running.

If desired, pneumatic windshield wipers or other pneumatically operable devices may be readily connected into the pressure and suction conduits; the accessories in this case being modified for actuation both by suction and pressure. Thus, a windshield wiper 24, arranged for suction and pressure operation, may be used with the system; the wiper being connected into suction line 21 as at 31 by a suction pipe 30, and into communication with exhaust gas outlet 37 through a pressure pipe 39. Other pneumatic devices of this type can be readily connected into the system. Capped couplings 40 and 41 are shown provided in pipes 21 and 39, for this purpose.

What I claim is:

1. In an automobile having an engine with the usual carburetor, an intake conduit and an exhaust conduit in open communication from the engine exhaust valves to the atmosphere, improved fuel supply means comprising a capped main fuel tank and an open pressure connection between the exhaust conduit and the main fuel tank so arranged that when and only when the engine is running, positive pressure direct from the exhaust conduit is put on the fuel in the main tank, and a vacuum tank arranged to draw fuel from the main tank by intake suction and to deliver fuel to the carburetor by gravity, said vacuum tank comprising a reservoir chamber, a float chamber arranged in one-way communication with the reservoir chamber, a fuel line leading from the main tank to the float chamber, a suction line from the float chamber to the intake conduit, a float in the float chamber, a vent for the float chamber, valves for covering and uncovering the vent, the fuel line inlet, and the suction line inlet, and linkage means operable by the float and so constructed and arranged as to close the valves for the suction line and the fuel line and open the vent when the float chamber is full of fuel, and to close the vent valve and open the

fuel line and suction valves when the fuel level in the float chamber is low, whereby adequate fuel supply is maintained to the carburetor under all engine operating conditions.

- 5 2. In an automobile having an engine with the usual intake and exhaust conduits, the exhaust conduit being in open communication with the atmosphere, a carburetor and a main fuel tank, improved fuel supply means comprising a pres-
10 ure connection between the exhaust conduit and the main fuel tank to put the fuel tank under positive pressure when the engine is running, a vacuum tank adapted to draw fuel from the main
15 tank by intake suction and to deliver fuel to the carburetor by gravity, the vacuum tank having valve means adapted to cut off flow from the main fuel tank when the vacuum tank is full, a
20 conduit leading direct from the main fuel tank to the carburetor, and check valve means in said conduit arranged to permit flow of fuel direct

from the main fuel tank to the carburetor under exhaust pressure when exhaust pressure is high.

3. In an automobile having an engine with the usual carburetor and intake conduit and an exhaust conduit in open communication from the engine exhaust valves to the atmosphere, a capped main fuel tank and an open pressure connection between the exhaust conduit and the main fuel tank so arranged that when and only when the engine is running positive pressure direct from the exhaust conduit is put on the fuel in the main tank, and a suction operable fuel supply device independent of said pressure connection and in operative fluid connection with the engine intake and arranged to feed fuel to the carburetor and to draw fuel from the main tank when intake suction is high so that adequate fuel feed is maintained under all engine operating conditions.

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