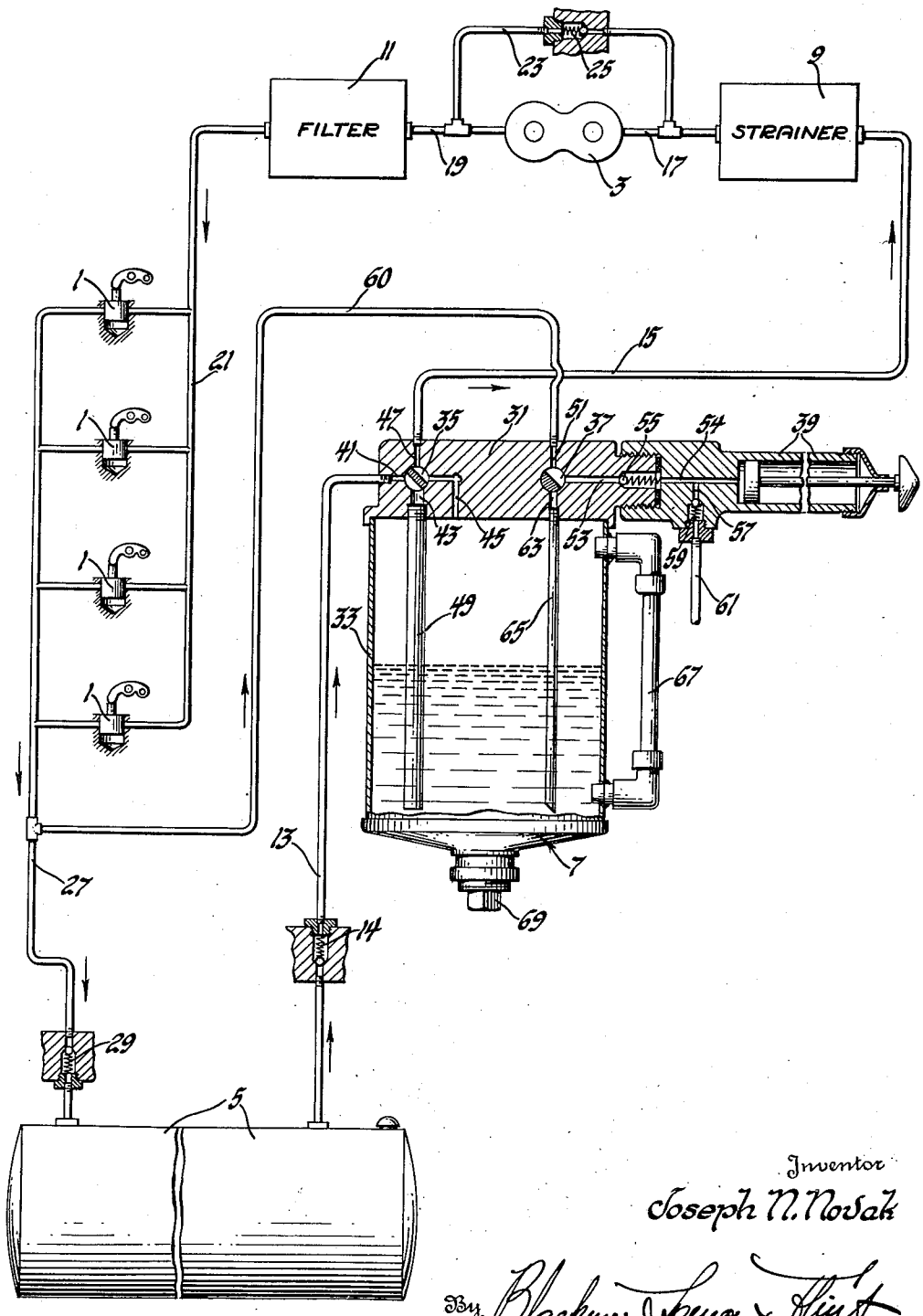
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ENGINE FUEL SYSTEM

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## ENGINE FUEL SYSTEM

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This invention generally relates to internal combustion engines and more particularly to fuel injection systems therefor.

The principal object of this invention is to provide a fuel system including means for separating impurities from the fuel while priming the system to insure complete filling of the system with fuel free of impurities and for evacuating the impurities and vapor therefrom before starting of the engine and during operation thereof to insure prompt starting and efficient engine operation.

The fuel system including novel means by which this object is accomplished and other features thereof will become apparent by reference to the following detailed description and single schematic drawing illustrating one form of the invention.

The fuel system includes a plurality of engine operated fuel injectors 1 adapted to be supplied with an excess of liquid fuel under pressure for combustion in order to also permit cooling and scavenging the injectors by an engine driven fuel transfer pump 3 from a fuel tank 5 through a separator 7, a strainer 9, a filter 11 and connecting supply pipes 13, 15, 17, 19 and 21, respectively. A non-return spring seated check valve 14 is included in the tank outlet pipe 13, and a by-pass pipe 23 including a check valve 25 is connected between the inlet and outlet pipes 17 and 19 of the transfer pump 3. The check valve 25 is seated by a spring and the outlet pressure of the transfer pump 3. The excess fuel supplied to the injectors is returned to the fuel tank 5 by means of injector outlet branch pipes and a return pipe 27 including a spring seated check valve 29 which is opened by the pressure of the fuel returned.

The separator includes a header 31 and a detachable bowl 33. The header is provided with two manually operable valves 35 and 37 and a manually operable plunger pump 39 is threaded thereto.

The valve 35 serves as a by-pass and separating valve and is shown in the separating position to establish a connection between passages 41 and 43 in the header 31 and to also establish another connection between passages 45 and 47 in the header. The header passage 43 is of greater diameter than the other passages and a large diameter separator pipe 49 extends downwardly therefrom to a point adjacent the bottom of the bowl 33. The tank outlet pipe 13 is connected to the header passage 41 and the pipe 15 is connected between the header passage 47 and the inlet of the strainer 9. The header passage 45 opens into the top of the bowl 33. Movement of the valve 35 at right angles from the separating position, as shown, to the by-pass position connects the pipe 13 and header passage 41 to the

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header passage 47 and pipe 15 so that the separator is by-passed.

The valve 37 serves as a priming and evacuating valve and is shown in the priming position to connect a header passage 51 to connecting passages 53—54 in the header 31 and pump 39. A spring seated valve 55 is included in the passages 53—54 to serve as a pump inlet valve. A pump discharge passage 57 leads from the pump passage 54 and includes a spring seated check valve 59 which serves as a pump discharge valve. A priming pipe 60 is connected between the header passage 51 and the return pipe 27 at a point located between the injectors 1 and the check valve 29. A discharge pipe 61 is connected to the pump discharge passage 57. Movement of the valve 37 clockwise at right angles from the priming position as shown, to the evacuating position connects the header passage 53 to another header passage 63 from which a separator evacuating pipe 65 extends downwardly to the bottom of the separator bowl 33. The bowl is provided with gauge glass 67 connected between the upper and lower extremities of the separator bowl 33 and a drain plug 69 is provided in the bottom thereof.

Priming of the above described fuel system to insure evacuation of vapor and complete filling of the system with fuel, from which dirt and water is separated, is readily accomplished by placing the valves 35 and 37 in the separating and priming positions, respectively, as shown, and operating the plunger of the priming and evacuating pump 39 manually. This causes vacuum to be applied to the injector fuel return pipe 27 through the connected priming pipe 60 which causes the check valve 29 to be held in the seated position and through header passage 51, priming valve 37, header passage 53, pump inlet check valve 55, pump passages 54 and 57 and discharge of vapor through the pump discharge check valve 59 in the pump passage 57 and discharge pipe 61 of the pump 39 connected thereto to cause flow of liquid from the tank 5 to unseat the check valve 14 in the pipe 13 and flow through this pipe to the separator 7 via the header passage 41, by-pass and separating valve 35, enlarged header passage 43 and separator pipe 49 to the bottom of the separator bowl 33 to completely fill the bowl. The reduction in the velocity of flow through the large diameter separator pipe 49 and bowl 33 causes separation and settling of impurities such as water and sediment from the fuel to the bottom of the separator bowl 33. Complete filling of the remainder of the fuel system with fuel takes place through the by-pass and separating valve 35 in the header passages 45 and 47 of the separator, pipe 15, strainer 9, pipe 17, by-pass pipe 23 and open check valve 25 therein, pipe 19, filter 11, pipe 21, injectors 1, return pipe 27, prim-

ing pipe 60, header and pump passages 37, 53, 54, 57 and check valves 55 and 59 and the pump discharge pipe 61. Discharge of a quantity of fuel through the pump discharge pipe insures complete filling of the system with fuel and thereby insures prompt starting and efficient operation of the injectors 1 and engine. The impurities separated and settled in the bottom of the separator bowl 33 from the fuel during priming of the system are clearly indicated in the bowl gauge glass 67.

Evacuation of these indicated impurities from the separator bowl 33 is readily accomplished by movement of the valve 37 to the evacuating position to connect the evacuating pipe 65 leading from the bottom of the bowl to the header and pump passages 63, 53, 54 and 57 and discharge pipe 61 through which the impurities are evacuated by further manual reciprocation of the plunger of the pump 39. The valve 35 is left in the separation position and valve 37 is moved to the evacuating position when the engine is started and operated to cause continuous separation and settling of impurities from the fuel in the manner described above and to prevent return fuel from being forced by the transfer pump 3 through the above described priming and discharge pipes and passages and to cause return of fuel directly to the tank 5 through the return pipe 27 and check valve 29.

It will be evident that the impurities may be evacuated from the separator bowl 33 in the manner described when the engine is operating as the suction developed by the manually operated plunger pump 39 is applied to the bottom separator bowl 33 while the transfer pump 3 applies suction to the top of the bowl.

If desired the separator may be by-passed by movement of the valve 35 to the by-pass position to remove and replace parts of the separator while the engine is operating.

I claim:

1. A fuel system including a fuel tank, a fuel injector having a fuel supply connection connected to the fuel tank and including a fuel pump and a separator tank, said separator tank having a fuel inlet passage extending downwardly from the upper portion to the lower portion, and a fuel outlet passage in the upper portion to separate impurities from the fuel and evacuating pump means having a suction connection communicating with the lower portion of the separator tank and a discharge passage for evacuating separated impurities from the separator tank and for drawing fuel therein.

2. In a fuel system for an engine, a fuel tank, an engine fuel injector having fuel supply and return connections communicating with the fuel tank, said fuel supply connection including a fuel transfer pump and a separator tank having a gauge glass communicating with the upper and lower portions, a fuel inlet opening in the upper portion communicating with the fuel tank and a fuel inlet conduit leading downwardly therefrom to the lower portion of the separator tank and a fuel outlet opening in the upper portion of the separator tank communicating with the inlet of the fuel pump and evacuating pump means having suction and discharge passages for evacuating the separated impurities from the separator tank while the fuel transfer pump is operating, said suction passage of the evacuating pump communicating with the lower portion of the separator tank for drawing separated impurities from the lower portion of the separator tank and thereby applying suction to the fuel inlet conduit connected to the fuel inlet opening of the separator tank for drawing fuel therein.



3. In a fuel system for an engine, a fuel tank, a fuel injector having a fuel supply connection and a fuel return connection to said tank, fuel supply means in said supply connection including a fuel transfer pump and a separator for separating impurities passing therethrough to said injector, an evacuating pump for said separator, a check valve in said return connection for allowing only one-way flow of fuel from said injector to said tank and a two way valve connected to said return connection, said separator and said evacuating pump, said two way valve being movable to one position to connect said evacuating pump to said return connection for evacuating vapor from said injector and said connections in order to completely fill said injector and said connections with fuel free from impurities, said two way valve being also movable to a second position for connecting said evacuating pump to said separator for evacuating the separated impurities therefrom.

4. In a fuel injection system for an engine, a fuel tank, a fuel injector, a fuel transfer pump and a two way valve connected in series between said tank and said injector and a separator having inlet and outlet connections connected to said two way valve, said two way valve being movable to one position for connecting said separator in series with said transfer pump to separate impurities from the fuel supplied to said injector by said pump, said two way valve being also movable to a second position for connecting said transfer pump directly to said tank and an evacuating pump having a suction connection communicating with the lower portion of the separator and an impurity discharge opening and operable to evacuate impurities from the separator and to draw fuel therein when said separator is connected in series with the transfer pump.

5. A fuel injection system for an engine, a fuel tank, a fuel injector, a fuel transfer pump and a two way valve connected in series between said tank and said injector for supplying fuel to said injector, a separator having inlet and outlet connections connected to said two way valve, said valve being movable to one position for connecting said pump directly to said tank for supplying fuel to said injector directly from said tank, said valve also being movable to a second position for connecting said separator and said pump in series relation between said tank and said injector for supplying fuel free from impurities to said injector from said tank, a fuel return connection including a check valve connecting said injector to said pump, said check valve allowing only one-way flow of fuel from said injector to said tank, an evacuating pump, and a second two way valve connected to said fuel return connection, said separator and said evacuating pump, said second two way valve being movable to one position for connecting said evacuating pump to said fuel return line for evacuating vapor from said separator, said transfer pump, said injector and said return connection in order to completely fill said injector with fuel free from impurities, said second two way valve also being movable to a second position for connecting said evacuating pump directly to said reparator for evacuating the separated impurities therefrom.

6. In a fuel injector for an engine, a fuel tank, a fuel injector, a fuel supply connection and a fuel return connection from said tank to said

injector, said fuel supply connection including a check valve adjacent said tank allowing only one-way flow of fuel therefrom to said injector, a two way valve and a fuel transfer pump, a fuel by-pass connection connected between the inlet and outlet of said transfer pump and including a check valve allowing only one-way flow of fuel from the inlet directly to the outlet side of said transfer pump, a separator having fuel inlet and outlet connections connected to said two way valve which is movable to one position for connecting said transfer pump directly to said tank and which is also movable to another position to connect said separator in series relation with said transfer pump for supplying said injector with fuel free from impurities, said fuel return connection including a check valve adjacent said tank for allowing only one-way flow of fuel from said injector to said tank, an evacuating pump and a second two way valve connected to said fuel return line, said separator and said evacuating pump, said second two way valve being movable to one position for connecting said evacuating pump directly to said fuel return line for evacuating vapor from and completely filling said injector and said connections with fuel from said tank, said second two way valve also being movable to a second position for connecting said evacuating pump directly to said separator for evacuating the separated impurities therefrom.

7. In a fuel system for an engine, a fuel tank, a fuel injector having a fuel supply connection and a fuel return connection to said tank, fuel supply means in said supply connection including a fuel transfer pump and a separator for separating impurities passing therethrough to said injector, an evacuating pump for said separator, a valve in said return connection from said injector to said tank and a two way valve connected to said return connection, said separator and said evacuating pump, said two way valve being movable to one position to connect said evacuating pump to said return connection for evacuating vapor from said injector and said connections in order to completely fill said injector and said connections with fuel free from impurities, said two way valve being also movable to a second position for connecting said evacuating pump to said separator for evacuating the separated impurities therefrom.

8. In a liquid fuel supply system for a diesel-type engine having a manifold, a fuel reservoir, a fuel-water separator tank, a conduit connection from said reservoir to said tank, a conduit between said tank and said manifold communicating with the upper portion of said tank, a water outlet conduit communicating with the lower portion of said tank, a fuel overflow conduit communicating with said manifold, pump means having an inlet and an outlet, and valve means for connecting the inlet of said pump means alternatively with said water outlet conduit to discharge water from said tank or with said overflow conduit to prime said manifold of said engine.

9. In combination, a tank having an inlet and having an outlet near the top thereof, a sight gage attached to said tank for indicating liquid levels in said tank, a manually operable cylinder and piston pump mounted on said tank, pump supply and outlet passageways in a wall of said



tank and communicating with said pump, two check valves in said passageways, a first of said check valves in said supply passageway permitting flow toward said pump only, a second of said check valves in said outlet passageway permitting flow away from said pump only, two pump inlet passageways in a wall of said tank connected with said supply passageway and communicating with the inlet side of said first check valve, one only of said inlet passageways communicating with the lower portion of said tank, the other of said inlet passageways communicating with said outlet of said tank, and valve means for selecting one or the other of said pump inlets.

10. In a device for separating desirable and undesirable liquids of different specific gravity in combination with a continuous conduit system having a zone where said desirable liquid is used, a separating tank in said system upstream from said zone, an inlet for mixed liquids to said tank, an outlet to said system from that portion of said tank containing said desirable liquid, means for moving said desirable liquid through said system, a pump having an outlet and also having two inlet passageways, valve means for selecting either of said pump inlet passageways, one of said inlet passageways having a conduit connection communicating with that portion of said tank containing said undesirable liquid, and the other of said inlet passageways having a conduit connection communicating with said system downstream from said zone whereby said pump may discharge said undesirable liquid from said tank when said one inlet passageway is selected, or may pull desirable liquid through said tank into said system when said other inlet passageway is selected.

11. In combination, a tank having an inlet and having a first outlet near the top thereof, a second outlet for said tank communicating with the same near the bottom thereof, a pump mounted on said tank, said pump having an outlet, said pump having an inlet, and valve and conduit means for connecting said inlet of said pump alternatively with said first and second tank outlets.

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