

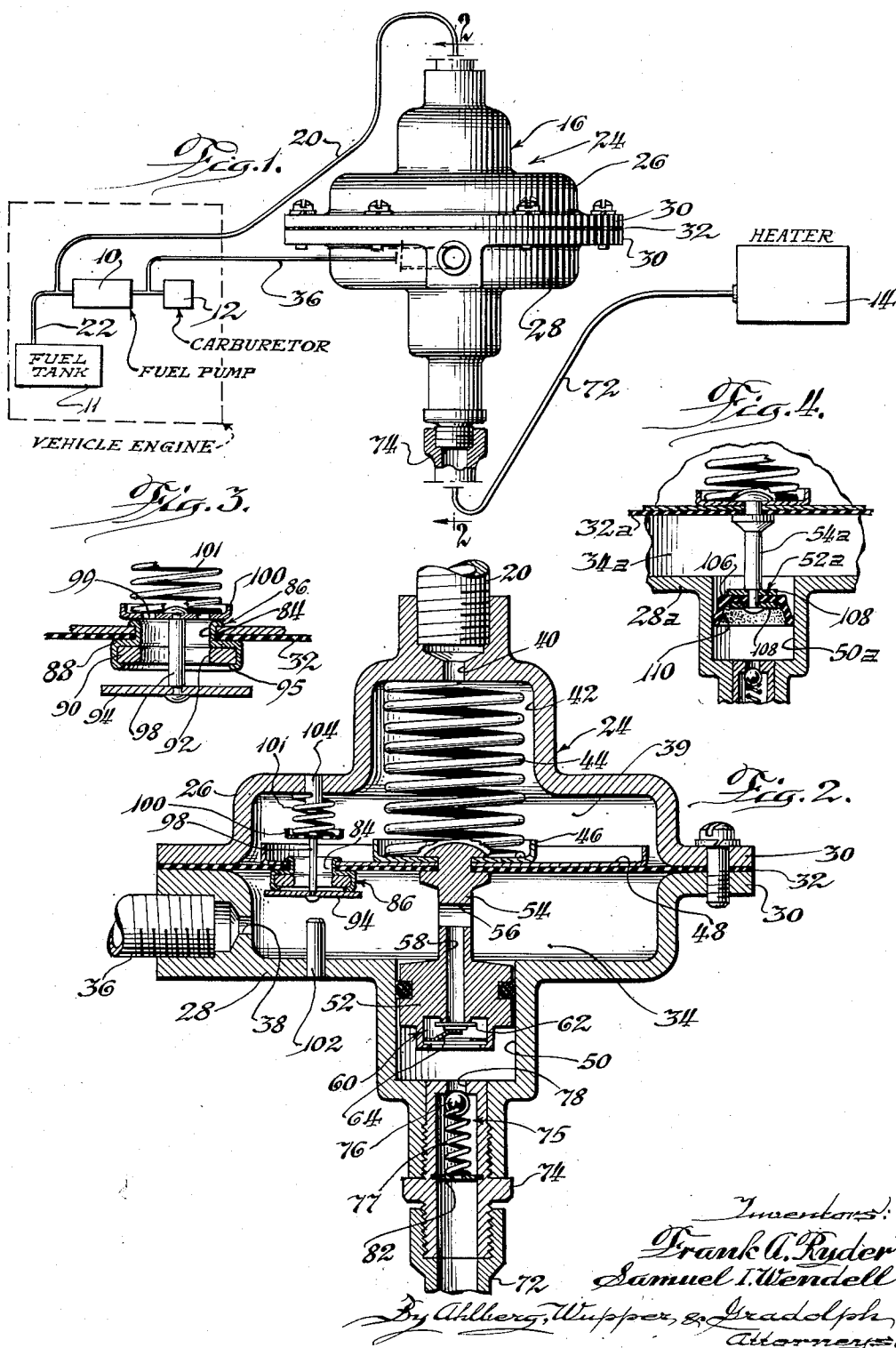
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FUEL SUPPLY SYSTEM FOR VEHICLE HEATER

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FUEL SUPPLY SYSTEM FOR VEHICLE HEATER

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The present invention is directed to the problem of supplying fuel under adequate pressure to combustion heaters for vehicles powered by internal combustion engines. Such heaters usually operate on the same fuel as the vehicle engines. Standard fuel pumps used on many vehicle engines supply fuel under about three pounds per square inch pressure. However, satisfactory operation of some vehicle heaters, particularly those employing atomizing nozzles, requires that the fuel be supplied to the heater at about fifteen pounds per square inch pressure.

One object of the invention is to provide for a nozzle type vehicle heater an economical, yet dependable, fuel system capable of supplying liquid fuel to the heater at a high pressure level when operated by a standard fuel pump which supplies fuel to the carburetor of the vehicle engine.

A more specific object is to provide for such a fuel system a simplified booster pump requiring no connection to the moving parts of the vehicle engine and capable when connected to the outlet of the engine fuel pump of supplying fuel at a sharply increased pressure.

Another object is to provide a booster pump of the above character that is capable of maintaining an elevated outlet pressure that is substantially unaffected by normal variations in the pressure of the fluid which drives the pump.

A further and more specific object is to provide such a booster pump controlled by a very simple valve arrangement.

Other objects and advantages will become apparent from the following description taken in conjunction with the drawing, in which:

Fig. 1 shows an elevational view largely in schematic form of a fuel supply system incorporating the invention;

Fig. 2 is an enlarged vertical sectional view of the booster pump taken along line 2—2 of Fig. 1;

Fig. 3 is a fragmentary sectional view on an enlarged scale showing the pump actuator control valve in open position; and

Fig. 4 is a fragmentary sectional view showing modified pump piston structure.

As indicated schematically in Fig. 1, most internal combustion engines (with the exception of diesels) for vehicles are equipped with a fuel pump 10 which supplies fuel from a tank 11 to a carburetor 12 under a pressure of the order of 3 p. s. i. Satisfactory operation of a high pressure nozzle type heater 14 used in the vehicle may require that the fuel be supplied to the heater under a pressure of about 15 p. s. i. to assure proper atomization of the fuel. The rate at which fuel is burned in the heater 14 is far less than that at which it is ordinarily supplied to the carburetor 12 and amounts to only a very small portion of the volumetric pumping capacity of the standard fuel pump 10.

Liquid fuel is supplied to the heater 14 under a predetermined high pressure by a booster pump 16 connected to the outlet of the standard fuel pump 10. An

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exhaust line 20 from the booster pump 16 is ordinarily connected to a supply line 22 running from the vehicle fuel tank to the standard fuel pump 10.

As shown, the booster pump 16 comprises a generally circular casing 24 formed by upper and lower half sections 26 and 28 fastened together. The casing 24 is well suited for low cost fabrication from sheet metal stampings. However, for the purpose of illustration, the two half sections 26 and 28 are formed as castings having mating flanges 30 bolted together.

A flexible diaphragm 32 secured between the two half sections 26, 28 extends transversely through the casing to define with the lower half section 28 an expandable pressure chamber 34. This chamber is connected to the outlet of the standard fuel pump 10 by a conduit 36 threaded into the lower casing section 28 and communicating with the chamber through a flow restricting orifice 38.

The space above the diaphragm 32 within the casing 24 forms an exhaust chamber 39 that communicates through an orifice 40 with the line 20 which leads to the inlet of the fuel pump 10.

The central portion of the upper casing section 26 is shaped to form a downwardly open boss 42, which receives the upper end of a compression spring 44. The lower end of the spring 44 presses against a cupped, circular spring seat 46 which nests within a thin reinforcing disc 48 of large diameter resting on top of the diaphragm 32.

The central portion of the lower casing 28 is shaped to form a pump cylinder 50 which opens upwardly into the pressure chamber 34 and receives a pump piston 52. The diameter of the pump piston 52 is much less than that of the diaphragm 32. A stem 54 extending upwardly from the piston 52 is secured to the central portion of the diaphragm 32, to the disc 48, and to spring seat 46.

Fluid can flow from the pressure chamber 34 into the lower end of pump cylinder 50 through a transverse bore 56 in the stem 54 and an axial bore 58 extending downwardly from the bore 56 through the piston 52. Reverse flow of fluid is prevented by a check valve 60 formed by a disc 62 held against the lower end of the axial bore 58 by a spring member 64 mounted in the lower end of the piston 52.

The pump cylinder 50 is connected to the heater 14 by a suitable tube 72 and a coupling 74 threaded into the lower casing section 28 just below the pump cylinder. The coupling 74 contains a check valve 75 formed by a ball 76 pressed by a spring 77 against the outlet of an orifice 78 communicating with the pump cylinder. The spring 77 is held in place by a snap ring 82 within the coupling 74.

An exhaust passage 84 connecting the pressure chamber 34 with the exhaust chamber 39 is formed in the diaphragm 32 by a hollow cylindrical member 86 extending through the diaphragm 32 and the reinforcing disc 48 at one side of the spring seat 46. The upper end of the member 86 is flared outwardly to tightly engage the upper surface of the disc 48. The lower end of the member 86 extends radially outward forming a disc 88 which tightly engages the underside of the diaphragm 32. The outer edge of the disc 88 is turned downwardly and rolled around the peripheral edge of a disc-shaped permanent magnet 90. A central opening 92 in the magnet 90 forms a downward continuation of the exhaust passage 84. This passage is larger in diameter than the inlet orifice 38 to the pressure chamber 34 or the outlet orifice 40 from the exhaust chamber 39.

The exhaust passage 84 is closed by valve means including a ferro-magnetic metallic disc 94 which upon movement into engagement with the lower rolled edge

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95 of the member 86 is held in place by the attraction of the magnet 90. A thin stem 98 extends upwardly from the center of the disc 94 through the passage 84 to connect with a cupped spring seat 100 preferably made of a nonmagnetic material and having a large number of openings 99 therein. A light helical compression spring 101 disposed between the upper casing section 26 and the seat 100 biases the valve disc 94 downwardly in opposition to the attraction of the magnet 90.

A pin 102 extends upwardly from the lower casing section 28 toward the lower side of the disc 94 to seat the disc against the member 86 upon downward movement of the diaphragm 32 to one extreme position by the spring 44. A second pin 104 extends downwardly from the upper casing section 26 through the valve spring 101 to engage the upper end of the stem 98 and unseat the disc 94 upon movement of the diaphragm 32 to an upper extreme position by fluid within the pressure chamber 34.

A review of the operation of the fuel supply system for the heater 14 may start with the assumption that the standard fuel pump 10 is not operating and that the pressure within the booster pump chamber 34 is reduced to a nominal value. Under such conditions the spring 44 will have forced the diaphragm 32 and the pump piston 52 downwardly to a lowermost position (in relation to Fig. 2) determined by the flexibility of the diaphragm 32 as reinforced by the disc 48 and spring seat 46. The valve disc 94 will be seated by the pin 102 against the cylindrical member 86, where it is held in closed position by the attraction of the magnet 90. The force of the spring 101 is not then sufficient to overcome the attraction of the magnet 90 on the disc 94 thus disposed in close proximity to the magnet.

Upon starting of the fuel pump 10, the flow of fluid into the pressure chamber 34 moves the diaphragm 32 upwardly compressing the spring 44 and raising the piston 52 within the pump cylinder 50. As the pump piston 52 moves upwardly the pump cylinder is filled with fluid flowing through the bores 56 and 58. The fluid pressure within the chamber 34 acts on the lower surface of the valve disc 94, providing an additional force tending to keep it seated.

As the diaphragm 32 reaches the upper limit of its travel, the pin 104 engages the upper end of the stem 98 to unseat the valve disc 94. The strength of the compressed valve spring 101 is greater than the force due to the attraction of the magnet 90 on the displaced disc 94 and thus snaps the disc to its fully opened position.

Opening of the exhaust passage 84 allows a substantial equalization of the fluid pressure on the opposite sides of the diaphragm 32. The rather strong compression spring 44 operates to force the diaphragm 32 and the pump piston 52 downwardly, expelling fluid from the pump cylinder 50 out through the check valve 75 and the tube 72 to the heater 14. When the diaphragm 32 reaches its lowermost position, the exhaust passage valve 94 is again seated by the pin 102 and the booster pumping cycle is repeated.

The strength of the operating spring 44 and the effective area of the pump piston 52 are designed to provide the desired outlet pressure from the pump cylinder 50. This pressure may be far in excess of that of the fluid supplied to the pressure chamber 34 by the fuel pump 10.

It will be appreciated, moreover, that the output pressure from the pump cylinder 50 is determined by the relationship of the pump piston size to the strength of the spring 44, and therefore is generally unaffected by normal variations in the pressure of the fluid supplied to the pressure chamber 34. The fluid pressure on opposite sides of the diaphragm 32 is substantially balanced at the time the spring 44 is actuating the pump piston 52.

It will be noted in particular that the operation of the booster pump 16 is controlled by a single valve carried in the reciprocable diaphragm 32 which serves as a piston for operating the pump piston 52. This results in an

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over-all simplification of the booster pump structure, which leads to strikingly economical manufacture of the unit.

A modified form of the booster pump piston is shown in the fragmentary view of Fig. 4. In this figure parts similar to those used in the first form of the invention shown in Figs. 1, 2, and 3 are designated with the same reference numerals with the addition of the subscript *a*. The pump piston 52_a of the modified construction comprises a rubber-like disc 106 clamped between two washers 108 on the lower end of a stem 54_a that extends upwardly to connect with the diaphragm 32_a. A conically shaped skirt 110 integral with the piston disc 106 extends downwardly into slidable engagement with the wall of the pump cylinder 50_a. It will be appreciated that this modified pump piston construction also serves as a check valve, the skirt 110 flexing to permit fluid to flow from the pressure chamber 34_a into the lower end of the pump cylinder 50_a. Upon downward movement of the piston 52_a, however, the skirt 110 is forced radially outward, forming a seal with the pump cylinder wall which prevents the flow of fluid past the piston.

While we have shown and described preferred embodiments of our invention, it will be apparent that numerous variations and modifications thereof may be made without departing from the underlying principles and scope of the invention. We therefore desire, by the following claims, to include all such variations and modifications by which substantially the results of our invention may be obtained through the use of substantially the same or equivalent means.

We claim:

1. A fluid operated booster pump for a heater, comprising, in combination, a casing, a flexible diaphragm partitioning said casing into a pressure chamber and an exhaust chamber, spring means connected to said diaphragm to urge the latter in a direction for compressing said pressure chamber, means on said casing defining a pump cylinder, a piston disposed in said cylinder and connected to said diaphragm, means for connecting said pressure chamber to a source of fluid under a relatively low pressure, one-way flow means providing for the passage of fluid from said pressure chamber into said pump cylinder, means including a check valve providing for the outflow of fluid from said pump cylinder, means forming an outlet from said exhaust chamber, means defining a passage through said diaphragm from said pressure chamber to said exhaust chamber, valve means on said diaphragm for closing said passage therethrough, and means for opening and closing said last mentioned valve means at the opposite extremes of the movement of said diaphragm.

2. A fluid operated pump unit comprising, in combination, a casing, reciprocable means coaxing with said casing to define therewith an expandable pressure chamber, means for admitting fluid under pressure into said chamber, a high pressure pump including a piston connected to said reciprocable means, means defining an exhaust passage in said reciprocable means, valve means including a ferro-magnetic member for closing said exhaust passage, a permanent magnet mounted to retain said exhaust passage valve in closed position, spring means mounted to urge said exhaust passage valve toward open position, means for opening said valve as an incident to movement of said reciprocable means in one direction to a first extreme position by fluid in said chamber, spring means mounted to move said reciprocable means in the opposite direction upon opening of said exhaust passage valve, and means for closing said exhaust passage valve as an incident to movement of said reciprocable means in said opposite direction to a second extreme position.

3. A fluid operated booster pump comprising, in combination, a casing, a diaphragm mounted in said casing and defining therewith an expandable pressure chamber, means on said casing defining a pump cylinder, a piston

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in said cylinder connected with said diaphragm, a passageway formed in said pump piston and leading from said pressure chamber into said cylinder, a check valve mounted to prevent reverse fluid flow through said passageway, means including a check valve forming an outlet from said pump cylinder, means for admitting fluid under pressure into said pressure chamber, means defining an exhaust passage through said diaphragm, valve means for closing said exhaust passageway and including magnetic means for retaining the valve means in closed position, spring means urging said exhaust passageway valve means toward open position, means for opening said exhaust passage valve means as an incident to movement of said diaphragm in one direction to an extreme position by fluid in said chamber, spring means mounted to move said diaphragm in the opposite direction upon opening of said exhaust passage valve means, and means for closing said exhaust passage valve means as an incident to movement of said diaphragm in the opposite direction to a second extreme position.

4. A fluid operated pump comprising, in combination, a casing, reciprocable means defining with said casing an expandable pressure chamber, means for admitting fluid under pressure into said chamber, means on said casing forming a pump cylinder, a pump piston in said cylinder connected with said reciprocable means, said piston including a flexible conical seal coacting with said pump cylinder to permit one way flow of fluid from said chamber into said cylinder, means forming an outlet from said pump cylinder, means defining an exhaust passage from said expandable chamber through said reciprocable means, valve means closing said exhaust passage, means for retaining said passage valve means in closed position, means for opening said exhaust passage valve means as an incident to movement of said reciprocable means to one extreme position by fluid in said chamber, spring means mounted to move said reciprocable means in the opposite direction upon opening of said exhaust passage valve means, and means for closing said exhaust valve means as an incident to movement of said reciprocable means in the opposite direction to a second extreme position.

5. For supplying liquid fuel under a relatively low pressure for use in an internal combustion engine carbureter and for supplying liquid fuel under a relatively high pressure for use in a vehicle heater, a pumping system comprising, in combination, a first pump for supplying fuel under a relatively low pressure, a fluid operated pump including a casing, a flexible diaphragm mounted in said casing and defining therewith a pressure chamber, means forming a restricted connection between said chamber and the outlet of said first pump, said restricted connection having a flow capacity substantially smaller than the output capacity of said first pump, means defining an exhaust passage in said diaphragm, a valve movably mounted on said diaphragm in association with said exhaust passage therein, valve opening means mounted to open said valve upon movement of said diaphragm in one direction to one extreme position by fluid in said pressure chamber, spring means connected to said diaphragm to be stressed upon movement of the diaphragm in said one direction and serving upon opening of said valve to force said diaphragm in the opposite direction thus compressing said chamber, valve closing means mounted to close said valve upon movement of said diaphragm in said opposite direction to a second extreme position, means defining a pumping chamber, means connecting said pumping chamber with said pressure chamber to receive fluid from the latter, a reciprocable pumping member connected to said diaphragm and coacting with said pumping chamber to expand and contract the latter upon movement of said diaphragm in said one direction and in said opposite direction, respectively, the strength of said spring and the effective area of said pumping member facing said pumping chamber being coordinated to exert a pressure

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upon fluid within said pumping chamber substantially greater than the outlet pressure of said first pump, and high pressure fuel discharge means extending from said pumping chamber.

6. A fluid operated booster pump unit for a heater, comprising, in combination, a casing, a flexible diaphragm partitioning said casing into a pressure chamber and an exhaust chamber, spring means connected to said diaphragm to urge the latter in a direction for compressing said pressure chamber, means on said casing defining a pump chamber, a reciprocable pump member connected to said diaphragm and coacting with said pump chamber alternately to expand and contract the latter as an incident to reverse movements of said diaphragm, means for connecting said pressure chamber to a source of fluid under a relatively low pressure, one-way flow means providing for the passage of fluid from said pressure chamber into said pump chamber, means including a check valve providing for the outflow of fluid from said pump chamber, means forming an outlet from said exhaust chamber, means defining a passage through said diaphragm from said pressure chamber to said exhaust chamber, valve means on said diaphragm for closing said passage therethrough, and means for opening and closing said valve at opposite extremes of the movement of said diaphragm.

7. A fluid operated pump unit comprising, in combination, a casing, reciprocable means coacting with said casing to define therewith an expandable pressure chamber, means for admitting fluid under pressure into said chamber, a high pressure pump having an inlet and an outlet and including a movable pump member connected to said reciprocable means, means for supplying fluid to said pump inlet, means defining an exhaust passage in said reciprocable means, a valve mounted on said reciprocable means in association with said exhaust passage therein and including a first magnetic member fixed to said reciprocable means and valve means including a second magnetic member movable toward and away from said first magnetic member to close and open said exhaust passage, one of said magnetic members constituting a permanent magnet adapted to exert an attractive force on the other magnetic member to hold said last mentioned valve means in closed position, spring means acting on said last mentioned exhaust valve means to urge the latter toward open position, means for opening said exhaust passage valve as an incident to movement of said reciprocable means in one direction to a first extreme position by fluid in said chamber, spring means connected with said reciprocable means to move the latter in the opposite direction upon opening of said exhaust passage valve, and means mounted to close said exhaust passage valve as an incident to movement of said reciprocable means in said opposite direction to a second extreme position.

8. A fluid operated booster pump unit for a heater, comprising, in combination, a casing, a flexible diaphragm partitioning said casing into a pressure chamber and an exhaust chamber, spring means connected to said diaphragm to urge the latter in a direction for compressing said pressure chamber, means on said casing defining a pump chamber, a reciprocable pump member connected to said diaphragm and coacting with said pump chamber alternately to expand and contract the latter as an incident to reverse movements of said diaphragm, means for connecting both said pressure chamber and said pump chamber to a source of fluid under a relatively low pressure, said connecting means including one-way flow means positioned to block reverse flow of fluid from said pump chamber, means including a check valve providing for the outflow of fluid from said pump chamber, means forming an outlet from said exhaust chamber, means defining a passage through said diaphragm from said pressure chamber to said exhaust chamber, valve means on said diaphragm for closing said passage there-

through, and means for opening and closing said valve at opposite extremes of the movement of said diaphragm.

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