

Sept. 8, 1936.

E. T. VINCENT

2,053,543

FUEL PUMPING SYSTEM FOR ENGINES

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2 Sheets-Sheet 1

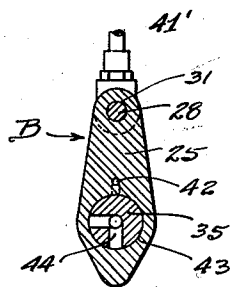
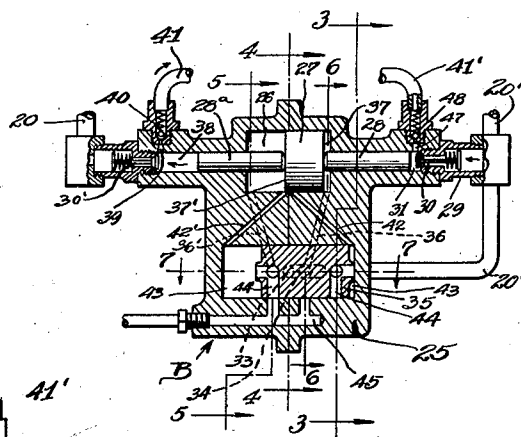
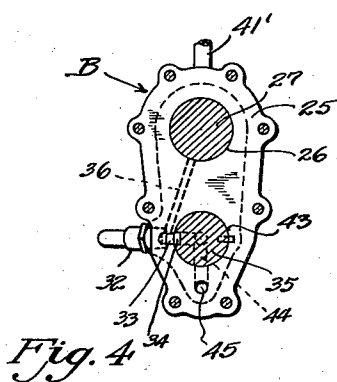
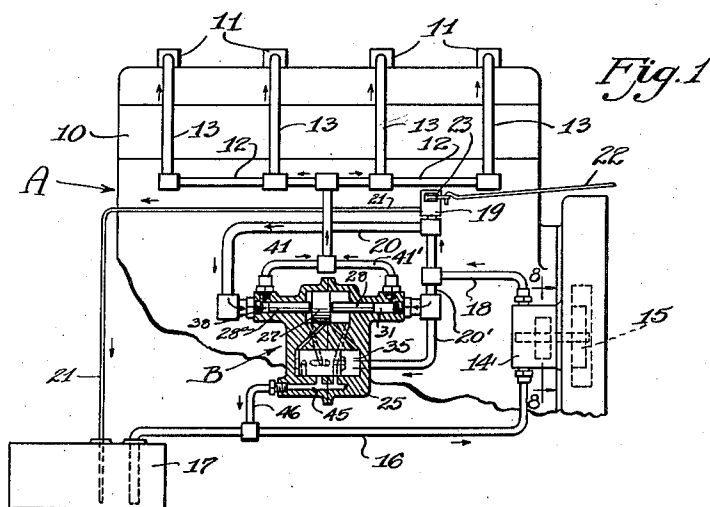


Fig. 5

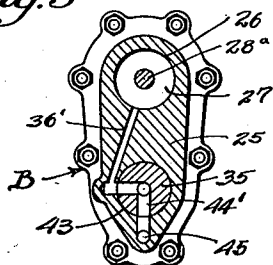


Fig. 3

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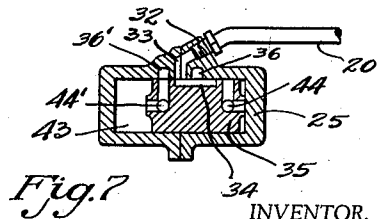
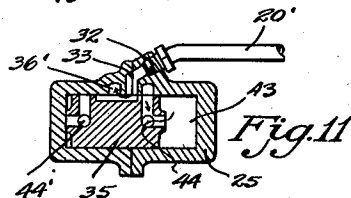
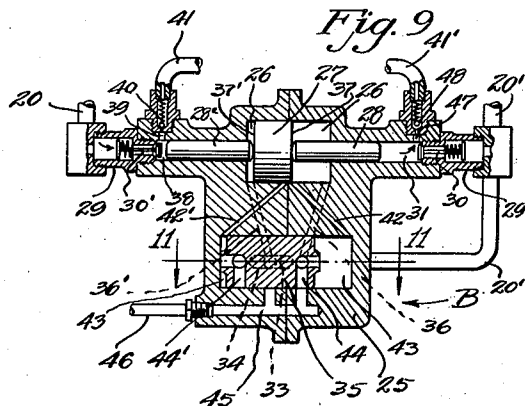
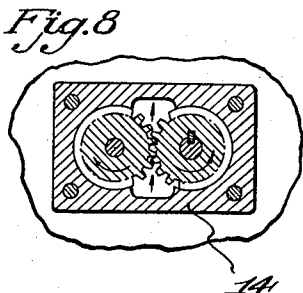
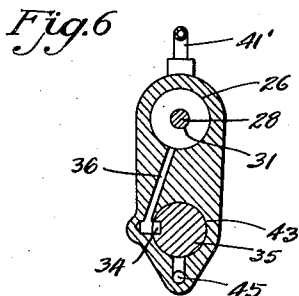
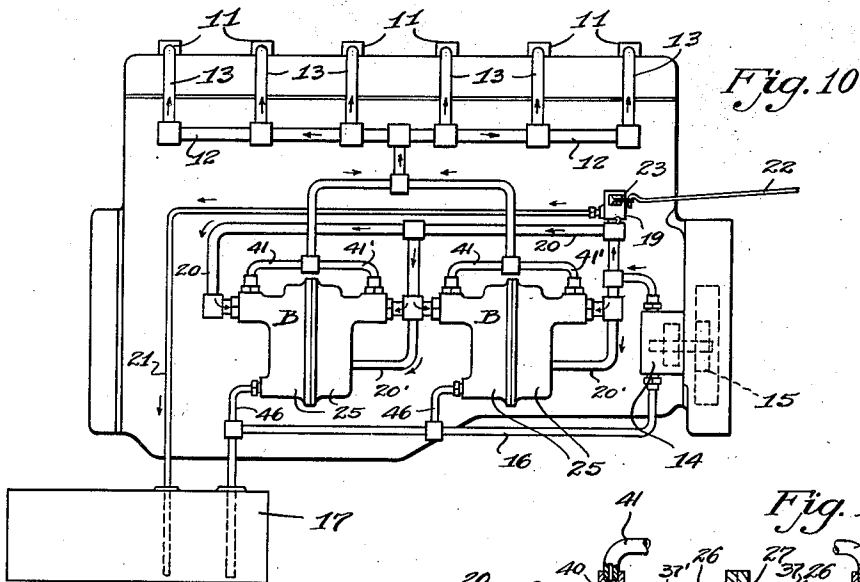
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2 Sheets-Sheet 2



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FUEL PUMPING SYSTEM FOR ENGINES

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3 Claims. (Cl. 103-5)

My invention relates to engines and more particularly to engines of the fuel injection type employing substantially a constant pressure in the fuel supply line associated therewith. My improvements reside generally in the means for maintaining such pressure in the fuel supply line.

An object of my invention is to construct an engine of the aforesaid type having generally improved operating characteristics.

Another object of my invention is to construct a generally improved fuel pumping means for an engine of the aforesaid type whereby a constant pressure in the fuel supply line may be maintained with a minimum of fluctuation of pressures.

A further object of my invention is to facilitate the manufacture of constant pressure fuel injection engines by providing a fuel pumping system of economical manufacture and which can be produced with a minimum of labor.

A still further object of my invention is to construct an improved fuel pumping system for an engine of the aforesaid type by providing co-operating low and high pressure pumps of relative economical manufacture and so constructed and arranged as to render efficient and reliable service with a minimum of maintenance cost and to outwear the usual type of pump now most generally employed.

For a more detailed understanding of my invention reference may be had to the accompanying drawings illustrating preferred embodiments of my invention, and in which:

Fig. 1 is a side elevational view of a fuel injection engine showing the high pressure pump in section,

Fig. 2 is an enlarged sectional view of the high pressure pump,

Fig. 3 is a transverse sectional view of the high pressure pump taken on the line 3-3 of Fig. 2,

Fig. 4 is a transverse sectional view of the high pressure pump taken on the line 4-4 of Fig. 2,

Fig. 5 is a transverse sectional view of the high pressure pump taken on the line 5-5 of Fig. 2,

Fig. 6 is a transverse sectional view of the high pressure pump taken on the line 6-6 of Fig. 2,

Fig. 7 is a longitudinal horizontal sectional view of the high pressure pump taken on the line 7-7 of Fig. 2,

Fig. 8 is a cross sectional view of the low pressure pump taken on the line 8-8 of Fig. 1,

Fig. 9 is an enlarged sectional view of the high pressure pump showing the same in reverse position from that illustrated in Fig. 2,

Fig. 10 is a side elevational view of an engine

equipped with a plurality of high pressure pumps, and

Fig. 11 is a horizontal sectional view taken through the valve member substantially on the line 11-11 of Fig. 9.

In the accompanying drawings I have shown one embodiment of my invention in connection with a fuel injection engine of the compression ignition type although it will be obvious that the principles of my invention may be incorporated in engines other than those of the aforesaid type.

The illustrated embodiment of my invention shows a multi-cylinder engine A having a cylinder head 10 and a plurality of fuel injecting or atomizing means 11. These fuel injectors are not shown in detail as they may be of any well known type. In the art of fuel injection engines the construction and injection operation of the fuel injectors or atomizers is well understood and forms no part of this invention per se. A "rail" or fuel supply line 12 is connected with each of the atomizing devices by the branch conduits 13. The engine is provided with a low pressure or primary pump 14 driven by gearing 15 from the engine crankshaft in any suitable manner, the pump 14 thereby preferably having a continuous pumping operation whenever the engine is running. The suction side of said pump communicates with a line 16 connected with the fuel tank 17 and the pressure side of said pump communicates with the fuel line 18 leading to the suction side of the high pressure or secondary pump structure B, a fuel pressure control 19 or other suitable relief valve being incorporated in line 18 to regulate the pressure supplied to the high pressure pump by conduit or other suitable fuel conducting means 20. An overflow pipe or conduit 21 leads from the fuel pressure control device 19 to the fuel tank 17. The said fuel pressure control device may be manually or automatically controlled, the structure herein illustrated showing an actuating rod 22 connected with a lever 23 associated with said device. Varying the fuel pressure delivered by the primary pump 14 will cause a corresponding variation in the fuel pressure delivered to the injectors 11 from the secondary pump B, the quantity of fuel injected varying in proportion.

Figures 2 to 9 inclusive illustrate in more detail the construction and operation of the high pressure pump structure B. This structure includes a casing 25 preferably formed of a two part casting which provides a pump chamber 26 in which a plunger or piston 27 is operated. Plungers 28 and 28^a are associated with the pis-

ton 27 and are of a diameter so proportioned and arranged with respect to the piston as to boost the fuel pressure to a predetermined degree. For example, if the engine is constructed for operation at maximum load with a fuel pressure of 6000 lbs. per square inch, the cross sectional area of the piston 27 and plungers 28, 28^a may be constructed with a ratio of 10 to 1 and thus necessitate a low pressure pump capable of building up a pressure of substantially 600 lbs. per square inch, the pressure control device 19 regulating the pressure supplied to said high pressure pump.

Referring to Fig. 2, it will be noticed that the fuel is delivered to the high pressure pump through the conduit 20' which is connected with a fitting 29, said fitting having a yielding seated valve 30 shown in Fig. 2 as being open to allow the fuel to flow into the plunger chamber 31 thus exerting a pressure on the piston 27 tending to move the same to the left. The conduit 20' is extended and is connected with the casing 25 by a fitting 32 and delivers fuel through an opening 33 into an elongated recess 34 carried by the shiftable cylindrical control valve 35. The casing 25 is provided with a passage 36 connecting the recess 34 with the chamber 26 behind the piston 27, thus conducting the fuel in such a way as to subject the rear face 37 of piston 27 to a pressure as built up by the low pressure pump 14. The advance of said piston 27 is resisted by the plunger 28^a operating within the plunger chamber 38. The plunger chamber 38 is provided with an outlet 39 controlled by a spring pressed ball valve 40, this outlet 39 being connected with a conduit 41 communicating with the rail or fuel supply line 12.

In order to more clearly describe the action of the high pressure pump, we may assume that the ratio between the areas of the piston 27 and the plunger 28^a is 10 to 1 as stated in the example heretofore outlined. Therefore movement of the piston 27 will be stopped when the pressure in the chamber 38 and communicating fuel supply line 41 reaches an amount equal to ten times the pressure tending to move the same. If the pressure from the low pressure pump is 600 lbs. per square inch, the resulting pressure in the fuel supply line 12 and communicating line 41 and chamber 38 will be 6000 lbs. per square inch. In the operation of the engine a certain amount of fuel is withdrawn from the fuel supply line and injected into the engine cylinders, thus causing the pressure in the fuel supply line 12 to drop. As the pressure in the fuel supply line tends to drop below the maximum maintained therein as for example 6000 lbs. per square inch, the piston 27 will advance until the pressure equal to this 6000 lbs. is built up in chamber 38. Successive injections in the engine cylinders tends to decrease the pressure in the fuel supply line but the pressure therein is maintained substantially constant by the action of this high pressure pump which constantly supplies added fuel at a predetermined pressure to said supply line as the same is used.

Preferably the capacity of the high pressure pump is such that a number of injections of fuel may be had with one stroke of the piston 27, as for example, the device herein illustrated may have a capacity sufficient to supply ten fuel injections to the engine. Thus for every ten fuel injections the action of the piston 27 is reversed. When the piston 27 is advanced to the left (see Fig. 2) as far as it will go, the piston uncovers the passage 42 and the fuel pressure behind the

piston is communicated to the valve chamber 43 and instantly shifts the valve 35 to a position as shown in Fig. 9. Thus that portion of the pump chamber 26 in which a fuel pressure as generated by the low pressure pump has been maintained, is vented through the passage 36 and passage 44 in the valve member to the vent 45 in the casing 25, this vent being connected with the line 16 by a connection 46. On shifting this valve member 35 from the position as shown in Fig. 2 to that as shown in Fig. 9, the valve 30' is opened and the fuel from the low pressure pump is conducted to the chamber 38 from the line 20, the ball valve 40 being seated to close the outlet 39 as the pressure in the line 41 is in excess of the pressure in chamber 38.

The demands on the fuel supply line tend to reduce the fuel pressure in said fuel supply line and the branch lines 41 and 41', said line 41' communicating with the outlet 47 associated with the chamber 31, said outlet 47 being controlled by a spring pressed ball valve 48. The low pressure fuel from the low pressure pump is conducted to that portion of the pump chamber 26 on the opposite side of the piston 27 and acts against the face 37', this fuel pressure being conducted thereto by the conduit 20', recess 34 which now is closed with respect to the passage 36 and opened with respect to the passage 36'. The action of the piston is the same as previously described with the exception that the piston now is moved to the right and maintains a predetermined constant pressure of 6000 lbs. in the chamber 31 and conduit 41' connected therewith. When the piston is moved to the right as far as it will go the piston will uncover the passage 42' and reverse the action and place the pump in the position as shown in Fig. 2, the valve being shifted to the right due to the pressure in the valve chamber 43 acting upon that end of the valve as shown at the left, as seen in Fig. 9.

While the pump chamber 26 on one side of the piston is subjected to a pressure from the low pressure pump and interconnecting conduits, that portion of the chamber on the other side of the piston is vented. For example, when the piston is positioned as shown in Fig. 2 the pump chamber 26 is vented through passage 36' and passage 44' in the valve member to the passage 45 in the casing. When the piston is in the position as shown in Fig. 9 that portion of the chamber 26 to the left of the piston is subjected to a pressure from the low pressure pump while that portion of the chamber to the right of the piston is vented through passage 36, passage 44 in the valve member to the passage 45 in the casing.

If desired two or more of said high pressure pump structures may be incorporated with an engine of the aforesaid type. In Fig. 10, I have illustrated such a modified form of construction embodying a pair of high pressure pumps constructed and arranged to operate in a manner similar to that previously described in connection with the pump illustrated in Figs. 2 to 9, inclusive. Such an arrangement as shown in Fig. 10 is preferably adaptable to a multi-cylinder engine requiring a greater amount of fuel than that illustrated in Fig. 1. This may be due to the fact that a greater number of cylinders are employed or to the fact that the cylinders are of larger diameter or bore. It would be preferable to so arrange the high pressure pumps when using two or more as to reverse the pistons at different times. This may be obtained by so arranging the same as to reverse the piston in one of the pump

structures while the other piston is in an intermediate portion of its stroke. This eliminates any tendency for the pressure in the fuel supply line to fluctuate to an excessive degree which may result at times when the piston is reversed due to a certain amount of lag in the action of the pump.

By employing a fuel pumping system as herein described, I find that the high pressure pump need not be as accurately machined or constructed with as close limits as a high pressure pump which must also measure the charge supplied to the engine cylinders. In fact, I have found that a clearance of .001" to .002" will be sufficient between the piston 27 and the walls of the pump chamber 26 and a clearance between the plungers 28 and 28* of approximately .0005" will be sufficient. Any leakage between these parts will be negligible and will not affect the pressure maintained in the fuel supply line as such leakage will merely leak back into the fuel tank. In the usual high pressure pumps generally employed, at present, a clearance of .00005" is quite common and thus exceedingly great care must be taken in the manufacture of such pumps, and in addition the material out of which said pumps are manufactured must be of the very highest grade whereas with my pump structure this is not so essential. Furthermore, the action of my high pressure pump is relatively slow as compared to the usual practice and thus wear is reduced to a minimum and the slow speed at which my pump is operated permits the use of materials of more economical construction than permitted by the pumps now generally used in which the speed of the parts is such as to necessitate the use of very high grade materials.

The pump 14 which I employ with my system is not a high pressure pump and therefore, may be more economically manufactured than the usual type of high pressure pump, due to the fact that relatively low fuel pressures are present and do not require such accurate workmanship. Furthermore, the incorporation of a fuel pressure control cooperating with the pressure side of the low pressure pump provides a very accurate control of the system and the device may be more economically manufactured due to the fact that it need not be as sensitive as a control device associated with a high pressure fuel supply line.

Another advantage of a construction as herein described and illustrated, is that if for any reason the fuel pressure in the fuel supply line 12 increases or exceeds the desired figure, due to the clogging or blocking of an atomizer or connecting conduits associated therewith, the high pressure pump merely stops and remains stationary until the pressure in said line again falls to the figure for which the pressure control device is set. Thus any clogging or blocking of

the fuel supply system does not injure or break the high pressure pump.

With the device as herein illustrated I find that a constant pressure may be maintained in the fuel supply line with greater accuracy than heretofore and my device is found to be especially adapted for use with a fuel injection engine of the multiple cylinder type.

It will be apparent to those skilled in the art to which my invention pertains that various modifications and changes may be made therein without departing from the spirit of my invention or from the scope of the appended claims.

What I claim as my invention is:

1. In a fuel pumping system for maintaining a substantially constant pressure in a fuel supply line and including; a secondary pump for delivering fuel to said fuel supply line under relatively high pressure, a primary pump operated to supply fuel under relatively low pressure to said secondary pump, means for operating said secondary pump by the fuel pressure produced by said primary pump, and means for varying the fuel pressure delivery from the primary pump to the secondary pump whereby to regulate the delivery pressure of the secondary pump.

2. In a fuel pumping system for maintaining a substantially constant pressure in a fuel supply line, a secondary pump for delivering fuel to said supply line under relatively high pressure; a primary pump arranged to supply fuel under relatively low pressure to said secondary pump; means for actuating said secondary pump by the fuel pressure produced by said primary pump; and a pressure regulating valve intermediate said pumps, arranged to control the pressure delivered by said primary pump to said secondary pump, and to thereby regulate the pressure delivered by said secondary pump.

3. In a fuel pumping system for maintaining a substantially constant pressure in a fuel supply line, a fuel supply receptacle; a secondary pump arranged to deliver fuel to said supply line under relatively high pressure; a primary pump arranged to withdraw fuel from said supply receptacle and deliver it to said secondary pump under relatively low pressure; means for actuating said secondary pump by said low pressure supplied by said primary pump; and pressure regulating means intermediate said pumps, arranged to control the pressure delivered by said primary pump to said secondary pump, and to thereby regulate the pressure delivered by said secondary pump, said pressure regulating means being arranged to by-pass excess fuel therefrom back to said supply receptacle.

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