

Oct. 28, 1941.

P. L'ORANGE

2,260,688

REGULATION OF THE SUPPLY OF FUEL TO INTERNAL COMBUSTION ENGINES

Filed Jan. 28, 1939

2 Sheets-Sheet 1

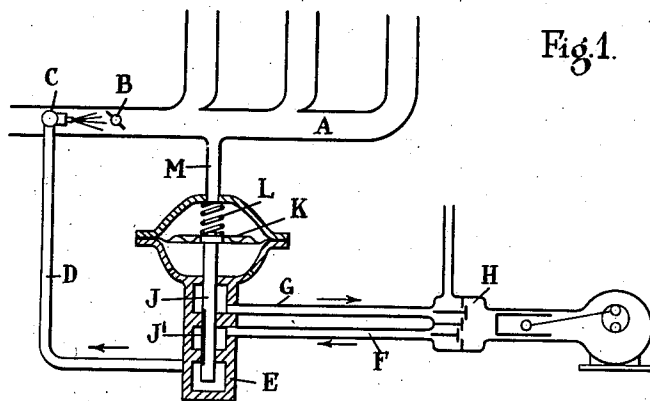


Fig. 1.

Fig. 2.

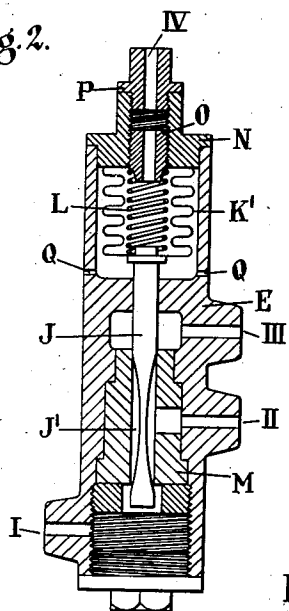


Fig. 3.

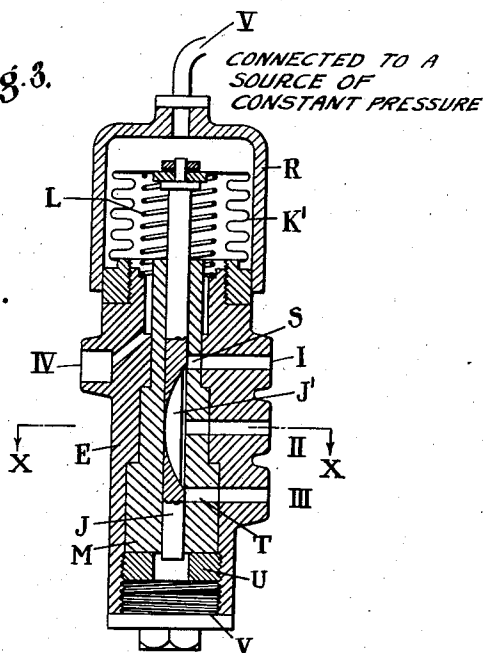
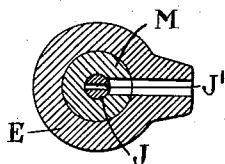


Fig. 4.



Inventor
Prosper L'Orange,
By: Smith, Michael & Gardiner,
Attorneys.

Oct. 28, 1941.

P. L'ORANGE

2,260,688

REGULATION OF THE SUPPLY OF FUEL TO INTERNAL COMBUSTION ENGINES

Filed Jan. 28, 1939

2 Sheets-Sheet 2

Fig.5.

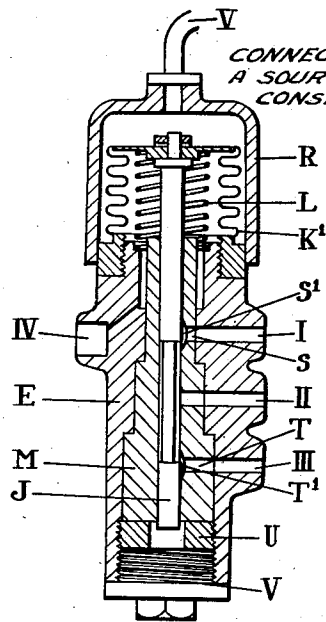
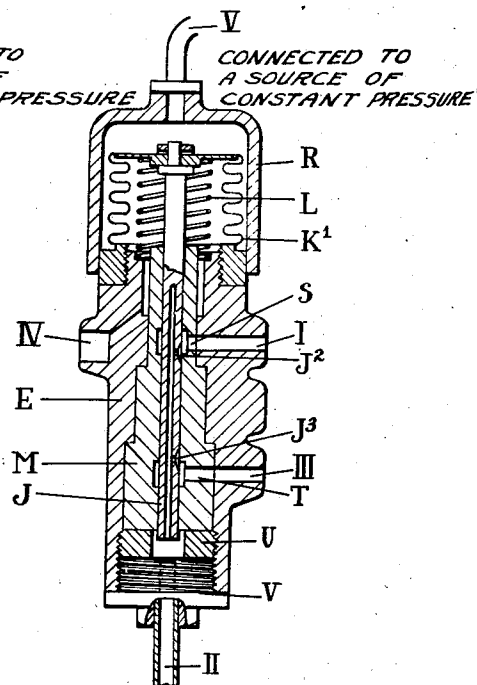


Fig.6.



Inventor: ~
Prosper L. Orange,
By: Smith, Michael & Gordiner,
Attorneys.

UNITED STATES PATENT OFFICE

2,260,688

REGULATION OF THE SUPPLY OF FUEL TO
INTERNAL COMBUSTION ENGINESProsper L'Orange, Stuttgart-Feuerbach, Ger-
many; Rudolf L'Orange executor of the estate
of said Prosper L'Orange, deceasedApplication January 28, 1939, Serial No. 253,452
In Germany June 4, 1935

4 Claims. (Cl. 123-140)

This invention relates to the regulation of the supply of fuel to internal combustion engines in which the combustible mixture is formed externally of the engine.

The automatic intake of fuel from a carburettor suffers from many disadvantages, which, due to the fact that the fuel feed to the supply nozzle is dependent upon the liquid level maintained by a float, arise particularly in cases where the engine is required to operate in any position, for example in an inverted position.

It has therefore been proposed to employ a pump for the supply of fuel in order to obtain a more positive feed, but in that case, difficulties arise in the regulation of the fuel supply in engines regulated by varying the quantity of fuel supplied, due to the fact that the quantity of fuel supplied must be adapted both to the engine speed and to the quantity of air determined by the throttling of the air supply.

If the output of the fuel supply pump itself is influenced by negative pressure in the intake passage of the engine, it is necessary to construct the pump in the manner of the injection pumps used in engines in which the mixture is internally formed; that is to say, the pump output must be capable of fine regulation, whereby unnecessary complications are caused. In the case of multi-cylinder engines in which the mixture is externally formed, the fuel must be injected by one nozzle into an intake passage common to all or a number of the cylinders, and the present invention provides a fuel feeding arrangement, applicable under such circumstances, which renders it possible to dispense with regulation of the output of the pump and therefore to employ a supply pump of a simple character such as has hitherto been employed as a feed pump.

According to the invention fuel from a pressure chamber supplied by a pump is passed to the engine induction passage, for the purpose of the regulation, through a throttle aperture the cross-section of which is adjusted proportionately to the negative pressure in a region of the induction passage between the throttle valve and the engine, surplus fuel being returned to the suction side of the pump.

If the surplus fuel were returned to the suction side of the supply pump through a throttle aperture of constant magnitude, the pressure of the fuel supplied to the engine would be too great at high engine speeds and too small at low engine speeds. On the other hand, if the fuel were returned to the pump through an aperture throttled by a spring-loaded valve, the pressure of the fuel

would be too small at high engine speeds and too great at low engine speeds.

Further according to the present invention, therefore, surplus fuel is returned to the pump through an aperture the magnitude of which is increased or reduced in the same proportion as the magnitude of the throttle aperture leading to the injection nozzle is reduced or increased. This effect could be obtained by individually controlling each of the two apertures by means of the negative pressure in the induction passage. Preferably, however, for the sake of simplicity, both apertures are controlled by a diaphragm or its equivalent controlled in accordance with the negative pressure prevailing for the time being in the induction passage, and effecting the control of the fuel supply, for example by displacing a control piston which positively controls one aperture and negatively controls the other aperture.

In order that the invention may be clearly understood and readily carried into effect, reference will now be made to the constructional embodiments of the invention illustrated by way of example in the accompanying drawings, in which—

Figure 1 illustrates diagrammatically a complete fuel supply regulating installation in accordance with the invention;

Figure 2 illustrates in vertical section a modified form of the regulating device illustrated in Figure 1;

Figure 3 is a view similar to Figure 2, but illustrates a further modification of the regulating device;

Figure 4 is a section taken on the line X—X of Figure 3;

Figure 5 illustrates in vertical section another form of the regulating device; and

Figure 6 illustrates in vertical section a further embodiment of the regulating device.

Referring to Figure 1 of the drawings, the installation is illustrated as applied to an engine intake pipe A leading to a series of three cylinders and provided with a throttle valve B, and a fuel injection nozzle C supplied with fuel by way of a pipe D connected to a regulating device E. The casing of the regulator E contains three chambers, the lowermost one of which is connected to the nozzle C through the pipe D, whilst the centre chamber is connected by a pipe F to the pressure chamber of a pump H and the uppermost chamber is connected by a pipe G to the suction chamber of the pump H. All the chambers are traversed by a control piston J,

which has a longitudinal recess at J' of such length that when the piston is in its mid-position the upper limiting edge of the recess projects beyond the edge of the piston guide by a distance equal to that by which the lower limiting edge of the recess extends downwards below the edge of the guide.

The piston J is controlled by a diaphragm K attached to the upper end of the piston and loaded by a spring L. The diaphragm is enclosed in a casing providing a space above the diaphragm which communicates with the induction pipe A through a pipe M, and a space below the diaphragm communicating for example with the atmosphere.

The diaphragm spring L is so adjusted that when the negative pressure in the induction pipe A is of minimum value the piston is moved to its maximum extent in the downward direction so as to increase the size of the aperture through which the fuel is supplied to the nozzle C and approximately to close the upper aperture through which surplus fuel is returned to the suction chamber of the pump.

When the negative pressure in the induction pipe A increases, the diaphragm K is lifted by the air pressure against the action of the spring L and the aperture through which the supply to the nozzle takes place is so reduced as to have a minimum value, which is practically zero, when the negative pressure is greatest. Accordingly, the upper aperture through which surplus fuel is returned to the suction space of the pump is opened at the same time so that it is greatest during no-load operation and the sum of the cross-sections of the two apertures always remains approximately constant.

The total throttling of the fuel supply is thus so great that the influence of the throttling effect of the injection nozzle is negligible. For example, the throttling due to the regulating device may correspond to 3 atmospheres at the maximum engine speed, whereas that of the nozzle may only amount to about 60 centimetres of water column. If it is desired that the fuel supply pressure should be greater, the liquid flowing back to the pump may also be throttled between the regulator and the suction chamber of the pump.

In the construction illustrated in Figure 2, in which the diaphragm is in the form of a corrugated tube K', an accurately calibrated bush M is fitted in a casing E, and a control piston J having a part J' of reduced cross-section is secured at its upper end to the corrugated tube K' and arranged slidably in the said bush M. The said corrugated tube K' is tightly connected to a cover N screwed into the casing E, the said cover having a threaded bore which receives at its lower end a bored spring abutment O and at its upper end a cap P for connection to the tube extending to the air intake pipe of the engine. The said screw cap P and spring abutment O are both engaged by the same thread in the cover N. A loading spring L is arranged to bear against the spring abutment O, the said spring being so designed as to be expanded when the piston J has descended and the feed to the nozzle is fully open, and to be so highly compressed when the piston is in its uppermost position, in which it approximately cuts off the feed, as to remain in equilibrium with the greatest negative pressure occurring in the intake pipe. With this construction the port I is connected to the injection nozzle and the ports II and III to the pres-

sure chamber and the suction chamber respectively of the pump, whilst the air intake pipe of the engine is connected to the port IV.

The chamber in which the corrugated tube K' is enclosed communicates with the atmosphere through ports Q, R.

Figures 3 and 4 illustrate a construction in which the negative pressure in the intake pipe of the engine acts from below on the corrugated tube K' and the atmospheric air pressure, or a constant pressure from a specially connected chamber, acts thereon from above. In this case the port I of the casing E is connected to the injection nozzle and the ports II and III respectively to the pressure chamber and to the suction chamber of the pump, whilst the air intake pipe of the engine is connected to the port IV. The port V, when the cap R is mounted, is connected to a chamber maintained at constant pressure.

In this construction the control piston J is ground in the bush M and has a fine slot J', the upper and lower limiting edges of which co-operate with control edges formed by the edges of apertures S and T in order to control the size of the apertures S and T in proportion to the lift. The lift is effected by the movement of the corrugated tube K', which is actuated in the upward direction by the spring L, and in the downward direction due to the creation of a negative pressure in the space below it, which communicates with the air intake passage of the engine through the port IV.

The bush M is secured in position by a screw cap U, while the casing E is closed by a cover V.

Figure 5 illustrates a regulating device which is similar in construction to that illustrated in Figure 3, and the same reference numerals have been employed to designate similar parts in these figures. In Figure 5, however, the control piston J is of reduced diameter over a portion of its length and the upper and lower limiting edges of this reduced portion co-operate with fine incisions S' and T', formed at the ends of the apertures S and T respectively, in order to control the size of the said apertures S and T in proportion to the lift.

Figure 6 illustrates a further modification of the construction illustrated in Figure 3. In Figure 6, the control piston J is hollow and its bore communicates with two fine bores J² and J³ which co-operate with control edges formed by the edges of the apertures S and T, in order to control the sizes of the said apertures S and T in proportion to the lift. The port II, in this embodiment, is in communication with the bore of the control piston J by means of a passage extending through the cover V.

What I claim as my invention and desire to secure by Letters Patent of the United States is:

1. A fuel supply system for internal combustion engines comprising an intake manifold for said engine; a throttle valve within said manifold for controlling the flow of combustible mixture to said engine; a source of fuel; a fuel injection nozzle in said manifold in advance of the throttle valve therein; a pump for supplying fuel from said source to said nozzle; a regulating device positioned between said nozzle and said pump and including a casing having an inlet connected to the discharge side of the pump, a first outlet connected to said nozzle, a second outlet connected to said source of fuel, a single reciprocable valve member within said casing

having a valve part operable upon reciprocation of said valve member to control the flow of fuel from said inlet to said first outlet to regulate the flow of fuel from said pump to said nozzle and a valve part operable upon reciprocation of said valve member to control the flow of fuel from said inlet to said second outlet to regulate the flow of fuel from the pump to said source, and a pressure-responsive device connected to said valve member for actuating the same; and a connection between one side of said pressure-responsive device and the intake manifold at a point in said manifold between the throttle valve and engine, the other side of said pressure-responsive device communicating with a source of constant pressure, whereby the valve member and consequently the supply of fuel from the pump to the nozzle and to the source are simultaneously controlled in accordance with variations in the pressure within the manifold at the point of connection between said manifold and said pressure-responsive device.

2. A fuel supply system for internal combustion engines comprising an intake manifold for said engine; a throttle valve within said manifold for controlling the flow of combustible mixture to said engine; a source of fuel; a fuel injection nozzle in said manifold in advance of the throttle valve therein; a pump for supplying fuel from said source to said nozzle; a regulating device positioned between said nozzle and said pump and including a casing having an inlet connected to the discharge side of the pump, a first outlet connected to said nozzle, a second outlet connected to said source of fuel, a single reciprocable valve member within said casing having a valve part operable upon reciprocation of said valve member to control the flow of fuel from said inlet to said first outlet to regulate the flow of fuel from said pump to said nozzle and a valve part operable upon reciprocation of said valve member to control the flow of fuel from said inlet to said second outlet to regulate the flow of fuel from the pump to said supply, a pressure-responsive device connected to said valve member for actuating the same, and an expansion spring bearing against one side of said pressure-responsive device for normally maintaining the flow of fuel from said pump to said nozzle and interrupting the flow of fuel from said pump to said source; and a connection between that side of the pressure-responsive device on which said spring is effective and the intake manifold at a point in said manifold between the throttle valve and the engine, the opposite side of said pressure-responsive device

communicating with a source of constant pressure, whereby the valve member and consequently the supply of fuel from the pump to the nozzle and to the source are simultaneously controlled in accordance with variations in the pressure within the manifold at the point of connection between said manifold and said pressure-responsive device.

3. A fuel supply system for internal combustion engines as defined in claim 1 in which the reciprocable valve member is actuated by the pressure-responsive device to control the first and second outlets simultaneously and in inverse proportion.

4. A fuel supply system for internal combustion engines comprising an intake manifold for said engine; a throttle valve within said manifold for controlling the flow of combustible mixture to said engine; a source of fuel; a fuel injection nozzle in said manifold in advance of the throttle valve therein; a pump for supplying fuel from said source to said nozzle; a regulating device positioned between said nozzle and said pump and including a casing having a chamber therein communicating with a source of constant pressure, said casing having an inlet connected to the discharge side of the pump, a first outlet connected to said nozzle, a second outlet connected to said source of fuel, a single reciprocable valve member within said casing having a valve part operable upon reciprocation of said valve member to control the flow of fuel from said inlet to said first outlet to regulate the flow of fuel from said pump to said nozzle and a valve part operable upon reciprocation of said valve member to control the flow of fuel from said inlet to said second outlet to regulate the flow of fuel from the pump to said supply, and a pressure-responsive device connected to said valve member for actuating the same, said pressure-responsive device being positioned within the chamber in said casing with one side thereof responsive to the constant pressure within said chamber; and a connection between the opposite side of said pressure-responsive device and the intake manifold at a point in said manifold between the throttle valve and engine, whereby the valve member and consequently the supply of fuel from the pump to the nozzle and to the source are simultaneously controlled in accordance with variations in the pressure within the manifold at the point of connection between said manifold and said pressure-responsive device.

PROSPER L'ORANGE.