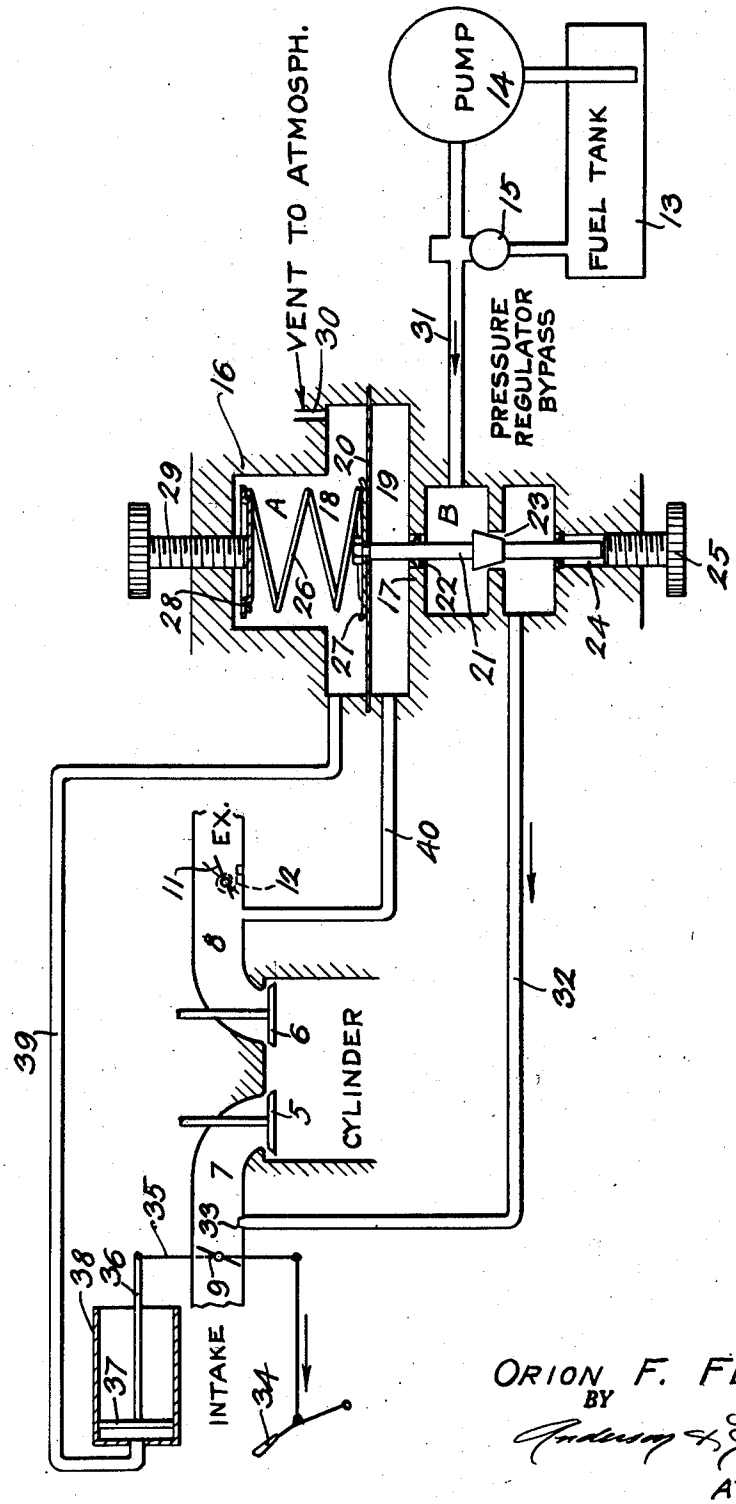
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FUEL INJECTION SYSTEM FOR INTERNAL COMBUSTION ENGINES

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INVENTOR.
ORION F. FLETCHER
BY
Andrews & Springer
ATTORNEYS

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FUEL INJECTION SYSTEM FOR INTERNAL COMBUSTION ENGINES

Orion F. Fletcher, Denver, Colo.

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This invention relates to improvements in fuel injection systems for internal combustion engines.

It has been the general practice to employ one of the many types of carburetors to effect a combustible mixture of air and gasoline which is then delivered to the engine cylinders through an intake manifold. Carburetors have been greatly improved in late years but due to various causes and in particular to the increased speed and power of the present automobile engines new fuel injection systems have been developed many of which do not employ the conventional carburetor and the present invention relates to such systems.

It is evident that for starting and for rapid acceleration the engine must be supplied with an extra amount of fuel and for the most economical performance the quantity should be automatically reduced as the load decreases and this is effected by the cooperative action of the several elements of the present system in a manner which will be explained for which purpose reference will now be had to the accompanying drawing in which the single view is a diagram showing the relationship of the several elements.

Referring now to the drawing in which numerals **5** and **6** represent respectively the intake and the exhaust valves of one cylinder. Reference numbers **7** and **8** represent respectively the intake and the exhaust manifold. Numeral **9** designates the throttle valve and **11** designates a thermo-responsive valve of the butterfly type that is eccentrically mounted as shown and is biased toward closed by a spring **12** which is preferably of the bi-metallic type commonly employed with thermostats and is so related to the valve that it moves the valve counterclockwise as the temperature decreases and clockwise or towards more fully open position as the temperature increases. This valve is preferably provided with manually operable means for effecting an adjustment of its normal position which means has not been shown as it is well known. The fuel tank, gasoline pump and the pressure regulator bypass have each been so designated and in addition have been designated respectively by reference numerals **13**, **14** and **15**. Numeral **16** designates a metal body whose actual construction has not been shown but which has an upper chamber A and a lower chamber B that are separated by a partition **17**. Chamber A is separated into upper and lower compartments **18** and **19** respectively by a diaphragm **20** whose edges are sealed to wall. A valve stem **21** has its upper end attached to the center of the diaphragm and extends through a hole **22** in partition **17**, thence downwardly and through valve opening **23** and into opening **24** coming to rest on the top of screw **25** which serves as means to effect vertical adjustment of the valve stem. Positioned to project downwardly into opening **23** is a downwardly tapering frusto-conical enlargement that cooperates with the upper edge of the wall of hole **23** to control the flow of gasoline and this will be referred to hereinafter as a needle valve. Positioned in that part of chamber A which is above the diaphragm **20** is a coil spring **26** whose lower end rests on the top of disk shaped

member **27**. A plate **28** rests on the upper end of spring **26** and is engaged by the lower end of screw **29** which serves to adjust the initial compression of spring **26**. Chamber A has a vent **30** to atmosphere. A conduit **31** connects the outlet port of the gas pump with the top compartment of chamber B. Openings **29** and **24** are provided with suitable seals which have been shown but not designated by number. A conduit **32** communicates the lower compartment of chamber B with the intake manifold and terminates in a pressure jet **33** of which there is one for each cylinder. The throttle valve or valves are controlled by a foot pedal **34** and a bar **35** which moves in a clockwise direction to open the valve and has its upper end connected by a rod **36** with a piston **37** that is in cooperative relation with cylinder **38**. A vacuum line or conduit **39** communicates the cylinder with the compartment of chamber A, above the diaphragm, and pressure line or conduit **40** communicates the compartment below the diaphragm with that portion of the exhaust conduit between the cylinder and valve **11**.

Operation

Let us now assume that the engine is first started in the morning. The ignition switch (not shown) is closed and the starter switch is closed, whereupon the gasoline pump is put into operation. Chamber B and conduit **32** may be considered as full of gasoline. The driver opens the throttle valve and simultaneously therewith pulls the piston outwardly producing a partial vacuum which is communicated through conduit **39** to the upper compartment of chamber A and this flexes the diaphragm upwardly and moves the needle valve to full open position and this permits gasoline to flow freely under full pump pressure through conduit **32** and be discharged into the intake manifold through the pressure jet. As soon as the engine starts exhaust gas will enter the exhaust conduit and since valve **11** is partially closed the pressure will be communicated to the compartment below the diaphragm and exert an upwardly acting force thereon. In the meantime the suction on top of the diaphragm will be reduced to zero due to the action of vent **30**. As the engine continues to operate the temperature of the exhaust gas will continue to rise and valve **11** will move towards open position thereby reducing the pressure on the underside of the diaphragm, whereupon the needle valve will move towards closed position. The position of the needle valve for idling of the engine is regulated by screw **25** and the position of the throttle valve for idling is controlled or adjusted by the usual well known means.

If the throttle valve is suddenly opened the vacuum action on the top of the diaphragm and the increased pressure in the exhaust manifold will respond immediately and produce the needed supply of gasoline.

Particular attention is called to the fact that during normal operation of the engine the gasoline supplied will be governed by the pressure of the exhaust gas in that part of the exhaust conduit between the cylinder and valve **11**.

What is claimed as new is:

1. In an internal combustion engine, an intake conduit comprising a mixing chamber, a throttle valve controlled air inlet to said mixing chamber, a fuel discharge pressure jet in said mixing chamber, an exhaust gas conduit, a valve in said last named conduit spaced from the engine to form a gas pressure chamber, said valve being openable in response to the pressure of the exhaust gases and movable towards open position in response to the temperature of the exhaust gas, a source of liquid under pressure, conduit means connecting the pressure jet with the fuel source, valve means in the last named conduit controlling the flow of fuel therethrough, spring means urging the valve towards closed position, a suction pump

device operatively connected with the throttle valve forming means to produce a low air pressure when the throttle valve is moved towards open position, means comprising a diaphragm operatively connected with the valve and with the suction pump for moving the valve towards open position when the throttle valve is moved towards open position, and conduit means communicating the pressure of the exhaust gases to the opposite side of the diaphragm to urge the valve towards open position whereby the rate of fuel feed will be proportional to the pressure of the exhaust gases.

2. A fuel injection and charge forming device for use with internal combustion engines having a cylinder provided with an air intake conduit and an exhaust conduit, an unbalanced valve of the butterfly type positioned in the exhaust conduit, said valve having associated therewith spring means for urging it towards closed position and thermo-responsive means for moving it towards open position in response to an increase in the temperature of the exhaust gases, an air control valve in the intake conduit, a pressure jet in the air intake conduit, a source of liquid fuel under pressure, conduit means connecting the pressure jet with the fuel source, a fuel control valve in said conduit, spring means operatively associated with the valve urging it towards closed position, said valve having an elongated stem, a pressure responsive means comprising a diaphragm operatively connected with the valve stem forming means for controlling the position of the valve in accordance with the difference in pressure on opposite sides thereof, a suction pump operatively associated with the air intake valve and with the diaphragm for subjecting one side of the diaphragm to suction tending to open the fuel control valve whenever the air valve is moved to open position and conduit means connecting the exhaust conduit with the other side of the diaphragm subjecting it to the gas pressure in the exhaust conduit, whereby the valve will assume a position corresponding to the difference in pressure on opposite sides of the diaphragm.

3. Means for supplying fuel to an internal combustion engine having an intake conduit and an exhaust conduit

provided with an unbalanced butterfly type valve urged towards closing position by spring means operatively connected therewith, thermo-responsive means for moving the valve towards open position in response to an increase in the exhaust gas temperature, a pressure jet positioned in the intake conduit, a manually controlled air inlet valve positioned on the outside of the pressure jet forming a mixing chamber, a source of liquid fuel under pressure, a conduit communicating the pressure jet with said fuel source, a fuel control valve in said conduit, said valve comprising a body having an upper and a lower chamber separated by a partition, the lower chamber being separated into an upper and a lower compartment by a partition having a valve seat, a valve operatively associated with the valve seat, said valve having a stem projecting upwardly into the upper chamber, a diaphragm dividing the upper chamber into an upper and a lower compartment, the top of the valve stem being attached to the diaphragm, the wall of said upper compartment having a vent, a suction pump operatively connected with the air inlet valve, a conduit communicating the suction pump with the compartment above the diaphragm whereby the air pressure above the diaphragm will be reduced when the air supply valve is moved to open position, and a conduit communicating that portion of the exhaust conduit between the valve therein and the engine cylinder with the compartment below the diaphragm whereby the pressure in the exhaust conduit will be communicated to the underside of the diaphragm tending to hold the fuel control valve open, the combined action of the heat from the exhaust gases and the pressure of said gases acting on the valve to move it to open position, whereby the pressure on the diaphragm will be reduced permitting the valve to move towards closed position.

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