

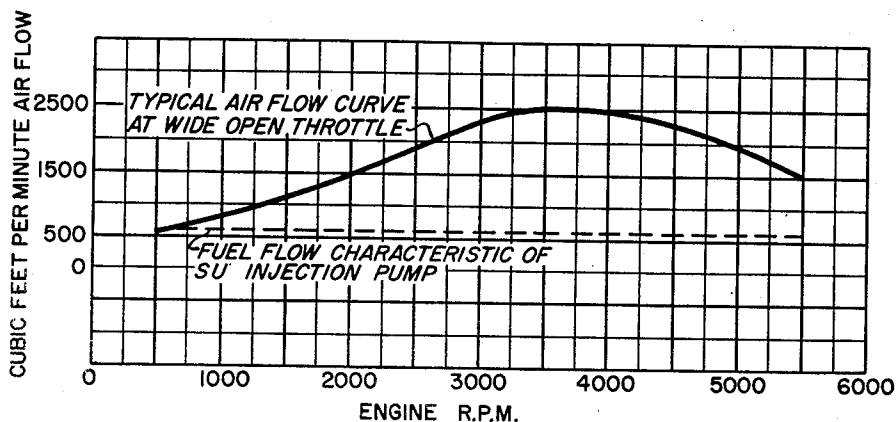
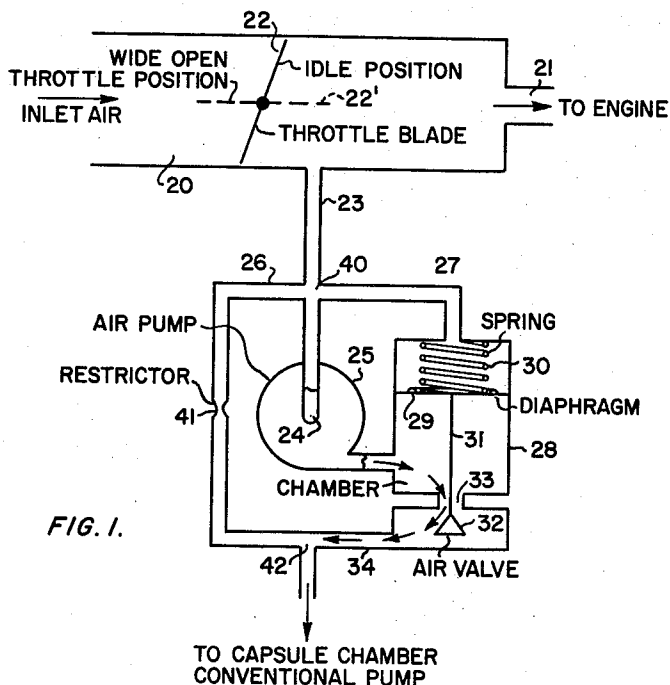
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N. W. BOSTWICK

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FUEL INJECTION CONTROL APPARATUS

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INVENTOR.

BY NORVAN BOSTWICK

Edwin E. Greigg

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FUEL INJECTION CONTROL APPARATUS

Norvan W. Bostwick, Montrose, N.Y., assignor to Simmonds Precision Products, Inc., Tarrytown, N.Y., a corporation of New York

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This invention relates to fuel injection control means specifically for the purpose of controlling the operation of fuel injection pumps and, more particularly, to the actuation of such means in relation to manifold pressures of fuel injection engines.

As work in this field has progressed, with the regulation of fuel delivery from variable discharge pumps in accordance with manifold pressures, it has been recognized that the results being attained do not provide the fuel economy desired, nor the most efficient fuel-air ratios ultimately attainable from a specific engine while it is operating at idling speed.

Accordingly, it has become a well-accepted fact that the conventional injection system has no means of compensating for the volumetric efficiency of the engine on which it is installed.

As it is well-known to those skilled in this art, volumetric efficiency may be defined as the ratio of the actual weight of air inducted per piston stroke when compared to the theoretical maximum weight which it is possible to induct at a standard pressure and temperature. Any particular engine has its own peculiar characteristics which are dependent upon many factors, such as the size of the valves, the total lift of the valves, the duration of valve opening, the type of intake manifold, as well as the type of exhaust manifold, etc. In order to increase the efficiency of the conventional four-cycle internal combustion engine, the use of ram manifolds has become popular. This concept utilizes the resonant length of the intake pipe leading to the intake pipe leading to the intake valve to attain a greater filling of the engine cylinders at certain speeds than would be otherwise possible. It is apparent to those acquainted with this particular field of endeavor that all of the foregoing, generally, combine to determine the manner in which the engine will consume air for combustion.

It has been also determined that, if some compensation is not made for the idling condition of any given engine, the fuel-air ratios become excessively rich. During low engine speeds, which condition exists during idling, the air consumption characteristics of the engine are such that the air consumed by a given cylinder per cycle is considerably less than at higher speeds and similar manifold pressures. The conventional fuel injection pump delivers substantially constant amounts of fuel per cycle at all speeds and at a given control pressure, which it will be immediately apparent, causes the fuel-air ratios to become too rich at idling conditions for the most efficient operation of the particular engine.

Some attempt has been made heretofore to provide for an independent idle fuel control by manually adjusting the injector control pressure at the idling throttle position and subsequently providing for a control pass-out range at throttle positions above idle speed so that the normal injection control will ultimately prevail.

In this concept, the principal object of the invention is to establish an efficient fuel-air ratio at engine idling speeds by providing a fully automatic fuel injection control means.

Still another object of the invention is to maintain independence of control at engine idling speeds by providing a manifold pressure sensitive method which will render an idling control means inoperative when the

throttle is advanced, thereby transferring control of the fuel injection to another more suitable means.

A still further object of the invention is the provision of a valving system and complete elimination of all mechanical connections and manual adjusting means.

The detail of the invention, as well as additional objects and advantages, will be clearly understood with reference to a preferred embodiment illustrated in the accompanying drawings employing similar reference numerals to identify the same elements in each of the several views, and in which:

FIG. 1 is a diagrammatic illustration showing the arrangement and operation of the invention; and

FIG. 2 is a typical air-flow curve of an engine at wide open throttle.

With reference to the drawings, and more particularly FIG. 1, a supercharged engine (not shown) is disclosed as being provided with an air intake system generally indicated by the air inlet 20 and a suitable outlet 21 leading to the engine manifold. A conventional butterfly or throttle blade is shown in closed (full line) position at 22 and in wide open (dashed line) throttle position at 22'. Forward of the butterfly, in its illustrated closed position for idling speed, there is shown a branch or conduit tubing 23 which is connected at 24 to the intake of a centrifugal-type air pump 25. As diagrammatically illustrated, branch conduits 26 and 27 are arranged to intersect the first conduit 23 at any predetermined point between the inlet manifold and its juncture with the air pump 25. The second branch conduit 26 is provided with a restrictor 41 and is arranged to extend to the capsule chamber of a conventional fuel injection pump (not shown). The third line or branch conduit 27 communicates with a substantially closed chamber, generally indicated at 28. The chamber 28 is provided with a diaphragm 29 between the upper surface of which and the top inner wall of the chamber is positioned a coil spring 30. To the lower surface of said diaphragm is attached a suitable shaft 31 to the terminal extremity of which is secured a valve member 32. The valve seat 33 is diagrammatically shown within the chamber 28 for cooperation with said valve. The lower wall of the chamber is provided with a suitable aperture which leads into a branch conduit or tubing at 34 which intersects or communicates with the branch conduit 26.

Accordingly, with the elements above described being connected in substantially the manner diagrammatically illustrated, the following operation will take place. With the throttle at wide open position, as illustrated in the drawing at 22', intake manifold pressure will exist at point 40 which is the juncture of branch conduits 26 and 27, one of which leads directly to the capsule chamber of the fuel injection pump, whereas the other branch conduit leads to the chamber 28 at a point above the diaphragm. A restrictor 41 is suitably provided in the line 26 and predeterminedly sized with respect to the pumping characteristic of the air pump 25, so that at low engine speeds the same manifold pressure exists at point 42. As the engine speed increases, the air pump 25 provides an air flow at a pressure which rises with respect to point 40, because as pump speed increases, there is a consequent increase to the restrictor 41, but pressure beyond restrictor 41 and at 40 remain constant. Because of the restrictor 41 the pressure in chamber 28 continues to rise with respect to the manifold air pressure, thus giving what may be termed "a falsified signal" to the capsule chamber of the fuel injection pump, thereby causing the pump to increase its fuel output, thus creating a wide open throttle characteristic of the particular engine. By referring to FIG. 2, it will be noted that at the peak of the volumetric efficiency curve, where the air flow begins to fall off or decrease, the pressure in chamber 28

has already risen to a point where it deflects the diaphragm against the spring, thus starting to close the air valve 32 against seat 33. Since the engine and fuel injection pump are directly connected, as is well-known to those skilled in the art, and their speed continues to rise, the pressure will also continue to rise in chamber 28, thereby closing the air valve 32 against seat 33. This condition will cause the pressure at the intersection of conduit 34 and conduit 26, diagrammatically shown at 42, to decrease. Accordingly, it will thus be apparent that with this decreased pressure at point 42, the fuel injection pump also decreases its output proportionately. Thus, it will be manifest that almost any curve of volumetric efficiency may be followed with the present device by making use of three or four variables present therein, that is, the air pump characteristics may be changed by making the pump larger or smaller or by varying the blade design. In addition, the spring weight of the diaphragm and the spring itself may be varied so that the air valve may start or begin to move at a different pressure and the ratio of movement with the pressure increase could be, accordingly, changed. The air valve itself could also be contoured to provide a linear or non-linear characteristic and the restrictor at 41 could be altered to various sizes and shapes. One or more of these variables, or all, could be changed to provide any desired curve in a particular engine.

Although the drawing does not illustrate an idle control, it will be apparent to those acquainted with the art that it would not involve the inventive concept to make such an installation in view of this teaching.

Although but one embodiment of the invention has been depicted and described, it will be apparent that this embodiment is illustrative in nature and that a number of modifications in the apparatus and variations in its end use may be effected without departing from the spirit or scope of the invention as defined in the appended claims.

What I claim as new and desired to secure by Letters Patent of the United States is:

1. In an apparatus for supplying fuel to an internal combustion engine having an air intake system, a throttle valve in said system and adjustable to regulate air flow through said system, and a variable delivery engine-driven fuel injection pump, provided with a pressure compartment and with a pressure-responsive control device in said compartment and operable to vary the fuel output of said injection pump, a control means for controlling the pressure in the pressure compartment of said pump during engine idling operation, having a first conduit connected with said air intake slightly downstream of the closure point of said throttle valve, said conduit terminating at the inlet of an air pump, second and third conduits branching from said first conduit, said second conduit terminating in a connection with said fuel injection pump, said third conduit terminating in a pressure-responsive device having a chamber, air outlet means extending from said air pump into said chamber, fourth conduit means extending from said chamber to said second conduit and pressure-responsive valving means in said chamber for controlling the pressure of said second conduit and said fuel injection pump.

2. In an apparatus for supplying fuel to an internal combustion engine as claimed in claim 1, wherein said chamber of the pressure-responsive device includes a spring-loaded diaphragm, the opposite surface of said diaphragm being arranged to support a valve means, said valve means cooperating with a suitable valve seat within said chamber, whereby upon increasing the speed of said internal combustion engine, the valve means within said chamber will close thus causing the output of the fuel injection pump to be decreased proportionately.

3. In an apparatus for supplying fuel to an internal combustion engine as claimed in claim 1, wherein a restrictor is provided within said second conduit, said restrictor being adapted to maintain a constant pressure at the intersection of said second and third conduits irrespective of the speed of said internal combustion engine.

4. In an apparatus for supplying fuel to an internal combustion engine having an air intake system, a throttle valve in said system and adjustable to regulate air flow through said system, and a variable delivery engine-driven fuel injection pump, provided with a pressure compartment and with a pressure-responsive control device in said compartment and operable to vary the fuel output of said injection pump, a control means for controlling the pressure in the pressure compartment of said pump during engine idling operation, having a first conduit connected with said air intake slightly downstream of the closure point of said throttle valve, said conduit communicating with a pressure generating means, second and third conduits branching from said first conduit, at least one of said conduits communicating with said fuel injection pump and the other of said conduits communicating with a pressure responsive device having a chamber, air outlet means extending from said pressure generating means into said chamber, fourth conduit means extending from said chamber to one of the aforesaid conduits and pressure responsive valving means in said chamber for controlling the pressure of the said one conduit and said fuel injection pump.

5. In an apparatus for supplying fuel in an internal combustion engine having an air intake system, a throttle valve in said system and adjustable to regulate air flow through said system, and a variable delivery engine-driven fuel injection pump, provided with a pressure compartment and with a pressure-responsive control device in said compartment and operable to vary the fuel output of said injection pump, a control means for controlling the pressure in the pressure compartment of said pump during engine idling operation, having a first conduit connected with said air intake slightly downstream of the closure point of said throttle valve, said conduit communicating with a pressure generating means, second and third conduits branching from said first conduit, said second conduit communicating with said injection pump, said third conduit communicating with a pressure responsive device having a chamber, air outlet means extending from said pressure generating means into said chamber, fourth conduit means extending from said chamber to said second conduit and pressure responsive valving means effective for controlling the pressure emitted from said chamber to said second conduit and said fuel injection pump.

6. In an apparatus for supplying fuel in an internal combustion engine as claimed in claim 5, wherein said chamber of the pressure responsive device includes a loaded diaphragm with the opposed surface thereof including a valve means, said valve means cooperating with a suitable valve seat means adjacent to said chamber, whereby upon increasing the speed of said internal combustion engine the valve means will close thereby causing the output of the fuel injection pump to be decreased proportionately.

References Cited in the file of this patent

UNITED STATES PATENTS

2,943,616 Boyer et al. ----- July 5, 1960

OTHER REFERENCES

Bosch, German application 1,113,851, printed September 14, 1961 (Kl. 46b² 16).