

Aug. 9, 1960

W. C. SUTTLE
FUEL SUPPLY SYSTEM

2,948,273

Filed May 22, 1957

5 Sheets-Sheet 1

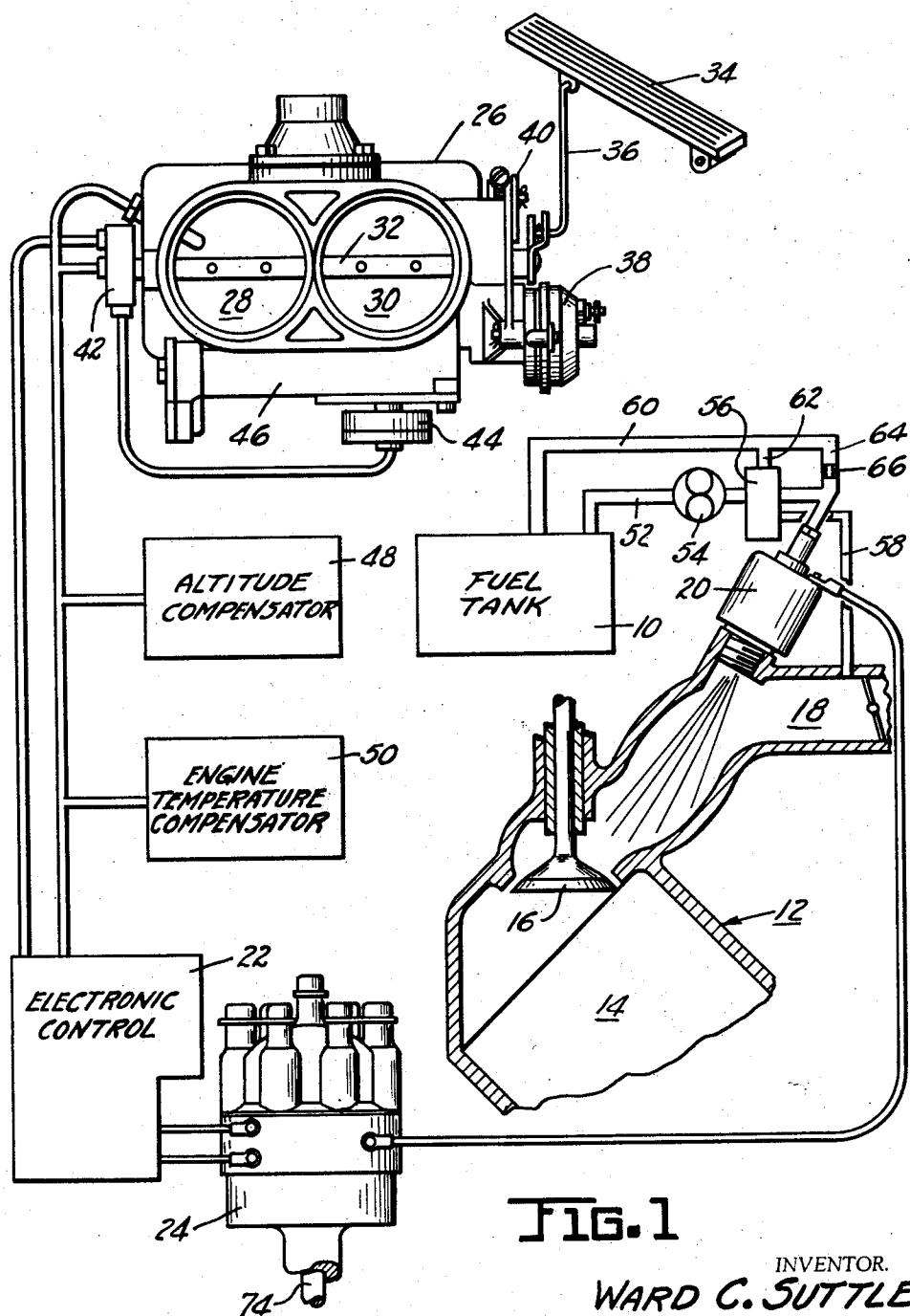


FIG. 1

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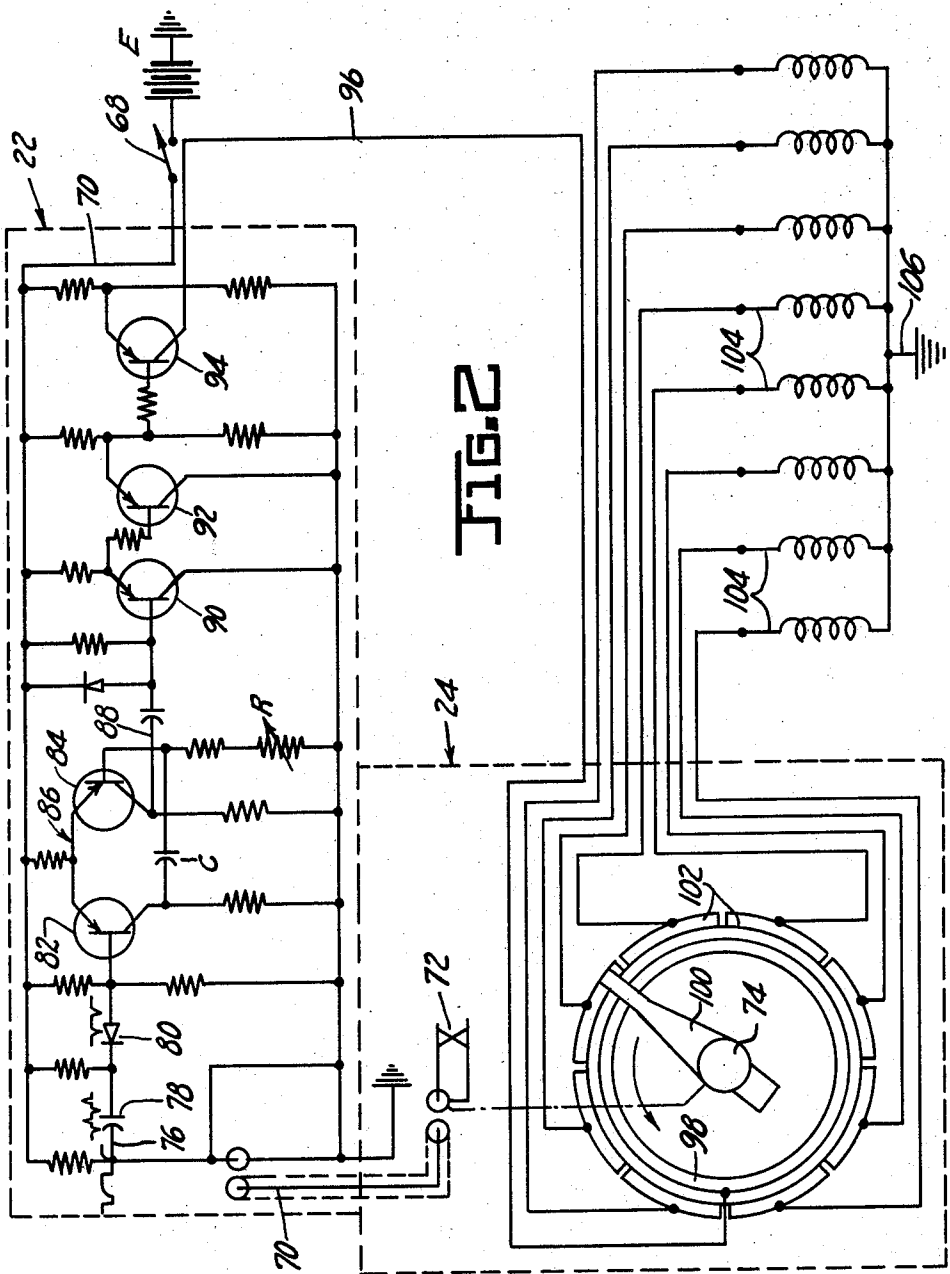
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5 Sheets-Sheet 3

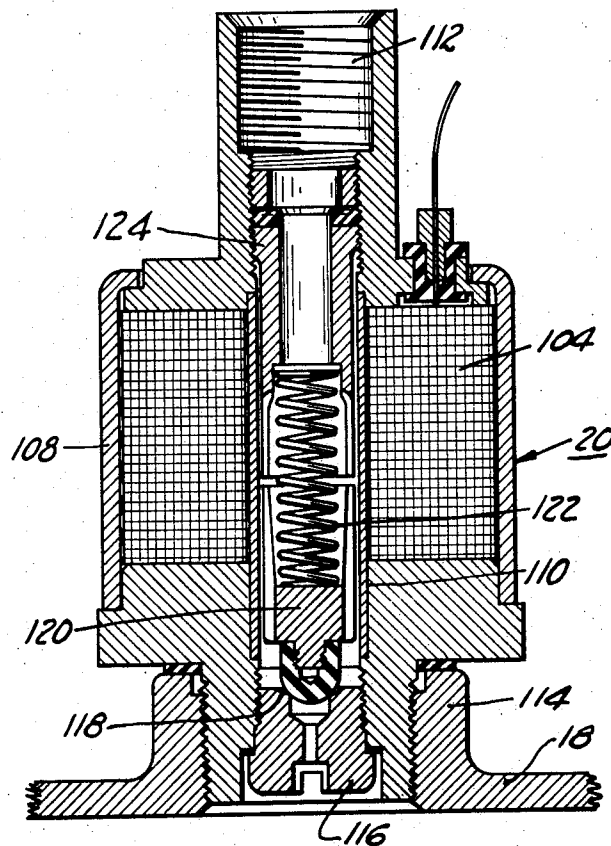


FIG. 3

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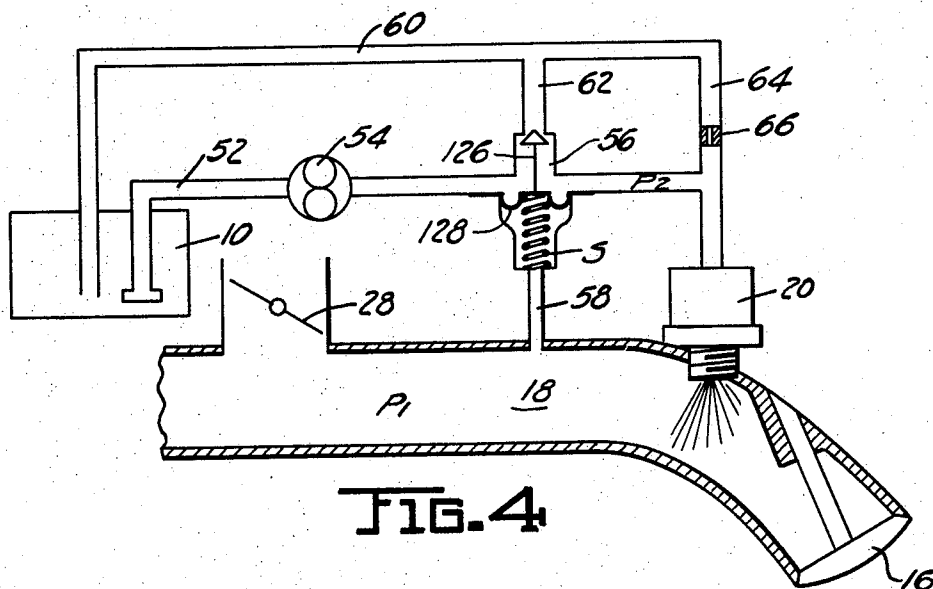
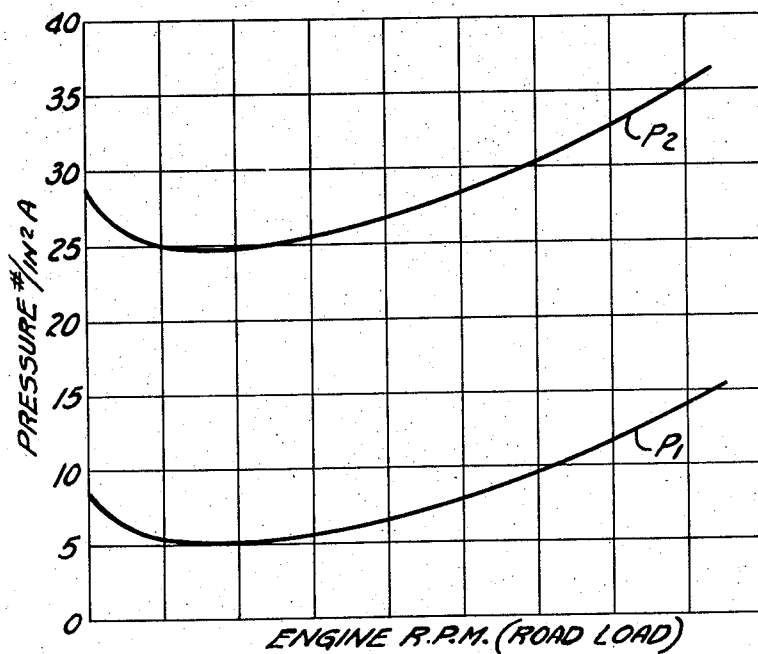


FIG. 5

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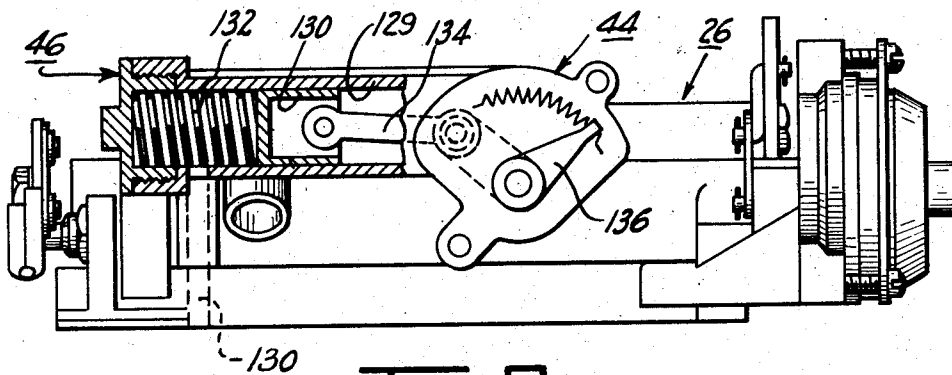


FIG. 6

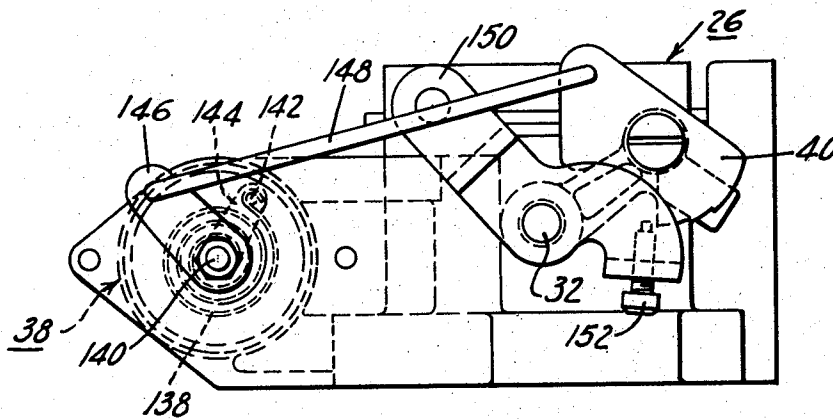


FIG. 7

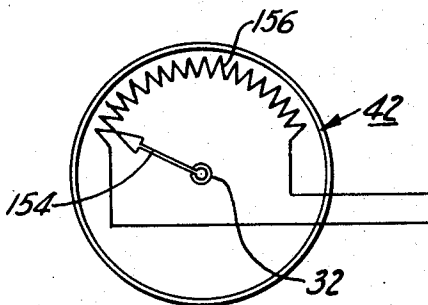


FIG. 8

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2,948,273

FUEL SUPPLY SYSTEM

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5 Claims. (Cl. 123—140)

The present invention relates generally to fuel supply systems for internal combustion engines and more particularly to a system wherein the fuel supplied to the engine is metered by varying the time duration of fuel discharge.

In such a system, fuel is normally supplied at a constant pressure to an injection nozzle mounted in the intake manifold. The nozzle is usually provided with an electrically actuated valve which is opened by an electronic timing device which in synchronism with engine speed opens the valve for varying periods of time as a function of the engine operating conditions such as induction passage pressure, atmospheric pressure, engine temperature, and atmospheric temperature. In such systems it is desirable that equal quantities of fuel be discharged from the nozzle for equal periods of valve opening. In systems where the fuel is supplied to the nozzle at a constant pressure it has been found, however, that equal quantities of fuel are not always discharged for valve openings of equal time duration. This is believed in part to be due to changes in the induction passage pressure which change during the operation of the engine to cause changes in a pressure differential across the nozzle discharge orifice.

Accordingly it is an object of the present invention to provide in a fuel supply system of the type described means for compensating the fuel supply pressure for changes in induction passage pressure.

Other objects and advantages will be readily apparent from the following detailed description taken in connection with the appended drawings in which:

Figure 1 is a schematic view of a fuel supply system embodying the present invention;

Figure 2 is a circuit diagram of the electronic control shown in Figure 1;

Figure 3 is a sectional view of the nozzle shown in Figure 1;

Figure 4 is a schematic view of the manifold and fuel supply system shown in Figure 1 with the parts somewhat re-arranged;

Figure 5 is a graph showing characteristic curves of fuel pressure and induction passage pressure versus engine speed;

Figure 6 is a front view partly in section of the throttle body shown in Figure 1;

Figure 7 is a view of the right side of the throttle body shown in Figure 1; and

Figure 8 is a sectional view taken along line 8—8 of Figure 1.

Referring now to the drawings and more particularly to Figure 1, numeral 10 designates a source of fuel, 12 an engine, 14 a cylinder or combustion chamber, 16 an inlet valve, 18 an air induction passage and 20 a fuel injector mounted to discharge fuel into said passage. The engine 12 may be provided with a plurality of combustion chambers and a number of injectors 20 may conveniently correspond with a number of combustion chambers although the proportion of injectors to com-

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bustion chambers may be increased or decreased as desired.

The injectors 20 are arranged to be actuated by an electronic control 22 which is triggered by and connected to an appropriate injector or nozzle 20 by a distributor-breaker unit 24. Unit 24 triggers or energizes the electronic control periodically as a function of engine speed. The electronic control 22, once energized, remains energized for a time duration controlled as a function of certain engine operating conditions. The output of the electronic control 22 is connected to an appropriate injector or nozzle 20 through the distributor portion of the unit 24. In systems having the plurality of fuel injectors the distributor unit 24 successively connects them to electronic control 22 as a function of engine speed. Each of the injectors 20 contains a valve energizable by a solenoid or other electrical means and when connected to the electronic control the valve opens for the time duration that the electronic control remains energized.

Air flow through the induction passage 18 is regulated by a throttle body unit 26 which is provided with a pair of throttle valves 28 and 30 mounted therein on a shaft 32 which is journaled in the side walls of the body unit 26. The throttle valves 28 and 30 are arranged for actuation by an accelerator pedal 34 acting through a linkage 36. A temperature responsive device 38 is operatively connected to a fast idle cam 40 which is disposed to engage a portion of linkage 36 to provide fast idle control of the throttle valves. A potentiometer 42 is operatively connected to throttle shaft 32 for actuation thereby. A potentiometer 44 is mounted on the throttle body unit 26 and is provided with an operative connection to an induction passage pressure responsive element 46 for actuation thereby. Potentiometers 42 and 44 are connected to the electronic control 22 by appropriate leads as are the altitude compensator 48 and engine temperature compensator 50.

The source of fuel 10 is connected to nozzle 20 by means of conduit 52 which contains a pump or pressurizing device 54 and fuel pressure compensator 56. Fuel pressure compensator 56 is connected to the induction passage downstream of the throttle valve by means of conduit 58 and is connected to the return fuel line 60 by means of passage 62. Nozzle 20 is connected to the return fuel line 60 by means of conduit 64 which contains restriction 66.

Referring now to Figure 2 which illustrates the circuit of electronic control 22, the potentiometers 42 and 44 and the altitude and engine temperature compensators 48 and 50 have been collectively designated as R. As shown in the figure, the source of electrical power E is connected through a switch 68 and conductor 70 with a switch 72 located in the distributor-breaker unit 24. Switch 72 is mounted for actuation by a shaft 74 which is adapted to be driven as a function of engine speed. When switch 72 is opened and closed a series of substantially square shaped pulses are formed in conductor 76. The square shaped pulses in conductor 76 are changed by capacitor 78 and rectifier 80 into a series of negative voltage spikes which are effective to trigger a normally non-conducting transistor 82 which together with transistor 84 forms a multivibrator unit 86. The multivibrator unit 86 produces a pulse of electrical energy in conductor 88 the width of which is a function of the time constant RC. Conductor 88 is connected through an amplifier, including cascaded transistors 90, 92 and 94, by means of conductor 96 to commutator 98 in the distributor-breaker unit 24. A wiper arm 100 driven by shaft 74 is arranged to successively connect the commutator 98 with segmental contacts 102 which are respectively connected to solenoids 104 in the nozzles

20. As shown the number of contacts 102 and solenoids 104 are eight in number for convenient installation on an eight cylinder engine. It is to be understood, however, that the number of segments and solenoids may be varied as desired. The solenoids 104 are connected to ground or reference potential by conductor 106.

As best shown in Figure 3 a nozzle 20 comprises a housing 108 which is provided with a central passage 110 which is threaded at 112 to receive fuel supply conduit 52. Body 108 is threadedly received in a boss 114 formed on the induction passage 18. The central passage 110 is threaded at its discharge end to receive a discharge orifice member 116 which is provided with a seat 118 for engagement with a valve or armature 120. Valve 120 is urged into engagement with seat 118 by a spring 122 which is received in an adjustable stop member 124. Solenoid 104 surrounds a portion of the central passage 110 and when energized moves valve 120 off of seat 118 permitting fuel to be discharged through the orifice member 116 for the time duration that solenoid 104 remains energized.

Referring now to Figure 4, the fuel pressure compensating control 56 is illustrated schematically to show a valve member 126 disposed to control flow of fuel from supply passage 52 to the return passage 62. Valve 126 is operatively connected to movable wall or diaphragm 128 which is urged by spring S in a direction to close valve 126. Movable wall 128 is exposed on one side to pressure P_1 existing in the induction passage 18 by means of conduit 58 to urge valve 126 toward closed position. Movable wall 128 is exposed on its opposite face to fuel pressure P_2 existing in fuel supply conduit 52. The spring S is selected to have a predetermined force whereby fuel pressure P_2 will exceed pressure P_1 by a predetermined substantially constant differential equal to the value of the force of spring S. Figure 5 graphically illustrates the characteristic curves of pressures P_1 and P_2 versus engine r.p.m. As shown in Figure 5 although the absolute values of P_1 and P_2 are variable the differential between them is substantially constant over the operating range of the engine.

In operation, a fuel injection cycle is started by actuation of switch 72 which energizes multivibrator 86 to produce a pulse of electrical energy, the width or time duration of which is controllable as a function of the time constant RC. R may be varied as a function of throttle position, induction passage pressure, altitude, and engine temperature to vary the time duration of the electrical pulse in accordance with changes in these engine operating conditions. The pulse of electrical energy from the multivibrator 86 is amplified through transistors 90, 92 and 94 and delivered to the distributor portion of the distributor-breaker unit 24 for successive connection to the appropriate solenoids as a function of engine speed. The solenoids are energized for a time duration equal to the width or time duration of the electrical pulse received from the electronic control 22. When energized, the solenoids 104 are effective to open valves 120 and hold them open for the time duration of current flow to the solenoid. Fuel from source 10 will thus be discharged into the induction passage 18 to an injector nozzle 20 for the time duration that valve 118 remains open. The fuel pressure compensator 56 insures a constant pressure differential across the discharge orifice member 116 whereby for equal time duration of valve opening equal quantities of fuel will be discharged into the induction passage. As best seen in Figure 6, the induction passage pressure element 46 comprises a cylinder 129 connected at one end to the induction passage 18 posterior to throttles 28 and 30 by means of conduit 131. A piston 130 is mounted in cylinder 129 and is urged toward one of its extreme positions by a spring 132 located in the cylinders. A linkage 134 connects piston 130 to the wiper arm 136 of potentiometer 44 whereby

the resistance of potentiometer 44 is controlled as a function of induction passage pressure.

As best seen in Figure 7, temperature responsive element 38 comprises a thermostat 138 having one end fixed to a stud 140 on the throttle body and the other end hooked over a pin 142 secured to a lever 144. Lever 144 is connected to the fast idle cam 40 by means of lever 146 and rod 148. A throttle lever 150 secured to shaft 32 is provided with a screw 152 which is adapted to engage the stepped portion of cam 40 to determine the idle position of the throttle valves.

As best seen in Figure 8, potentiometer 42 comprises a wiper arm 154 secured to throttle shaft 32 for engagement with a resistance wire 156.

While a preferred embodiment of my invention has been described it will be readily apparent to those skilled in the art that various changes and arrangements can be made to accomplish the objects of the invention without departing from the spirit thereof.

I claim:

1. A fuel supply system for an internal combustion engine having an induction passage and a source of fuel comprising a nozzle, a discharge orifice in said nozzle opening into said passage, a conduit connecting said source with said nozzle, a valve in said conduit adapted to control the time duration of fuel flow through said orifice independent of engine speed and means responsive to induction passage pressure for maintaining a substantially constant pressure differential across said orifice throughout the operating range of said engine.

2. A fuel supply system for an internal combustion engine having an induction passage and a source of fuel comprising a nozzle, a discharge orifice in said nozzle opening into said passage, a conduit connecting said source with said nozzle, a first valve in said conduit, means responsive to induction passage pressure for controlling the time duration of opening of said first valve, a second valve in said conduit adapted to control the fuel pressure therein, and means responsive to induction passage pressure for regulating said second valve to maintain a predetermined substantially constant pressure differential between the pressures in said passage and conduit.

3. A fuel supply system for an internal combustion engine having an induction passage and a source of fuel comprising a nozzle mounted to discharge into said passage, a conduit connecting said source with said nozzle, means for controlling the time duration of flow through said nozzle, a passageway connecting said conduit intermediate the ends thereof to said source, a valve controlling the connection of said passageway to said conduit, resilient means urging said valve toward closed position and a movable wall operably connected to said valve and responsive to induction passage pressure for opening said valve whereby a substantially constant pressure differential is maintained between the pressures in said conduit and passage.

4. A fuel supply system for an internal combustion engine having an induction passage and a source of fuel comprising a nozzle mounted to discharge into said passage, a conduit connecting said source with said nozzle, means for controlling the time duration of flow through said nozzle, a passageway connecting said conduit intermediate the ends thereof to said source, a valve controlling the connection of said passageway to said conduit, resilient means urging said valve toward closed position and a movable wall operably connected to said valve and subjected on one side to pressures in said conduit and on the other side to pressures in said passage whereby a substantially constant pressure differential is maintained between the pressures in said conduit and passage.

5. A fuel supply system for an internal combustion engine having an induction passage and a source of fuel comprising a nozzle mounted to discharge into said passage, a supply conduit connecting said source with

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said nozzle, a return conduit connecting said nozzle to said source, a restriction in said return conduit, means for controlling the time duration of fuel flow through said nozzle as a function of an engine operating condition such as induction passage pressure, a passageway 5 connecting said supply and return conduits, a valve in said passageway, resilient means urging said valve toward closed position and a movable wall operably connected to said valve and subjected on one side to pressures in said supply conduit and on the other side to pressures in 10

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said induction passage whereby a substantially constant pressure differential is maintained between the pressures in said supply conduit and said passage.

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