June 20, 1961 J. N. HUMBER ET AL 2,989,044

FUEL INJECTION APPARATUS

Filed March 12, 1957 6 Sheets-Sheet 1

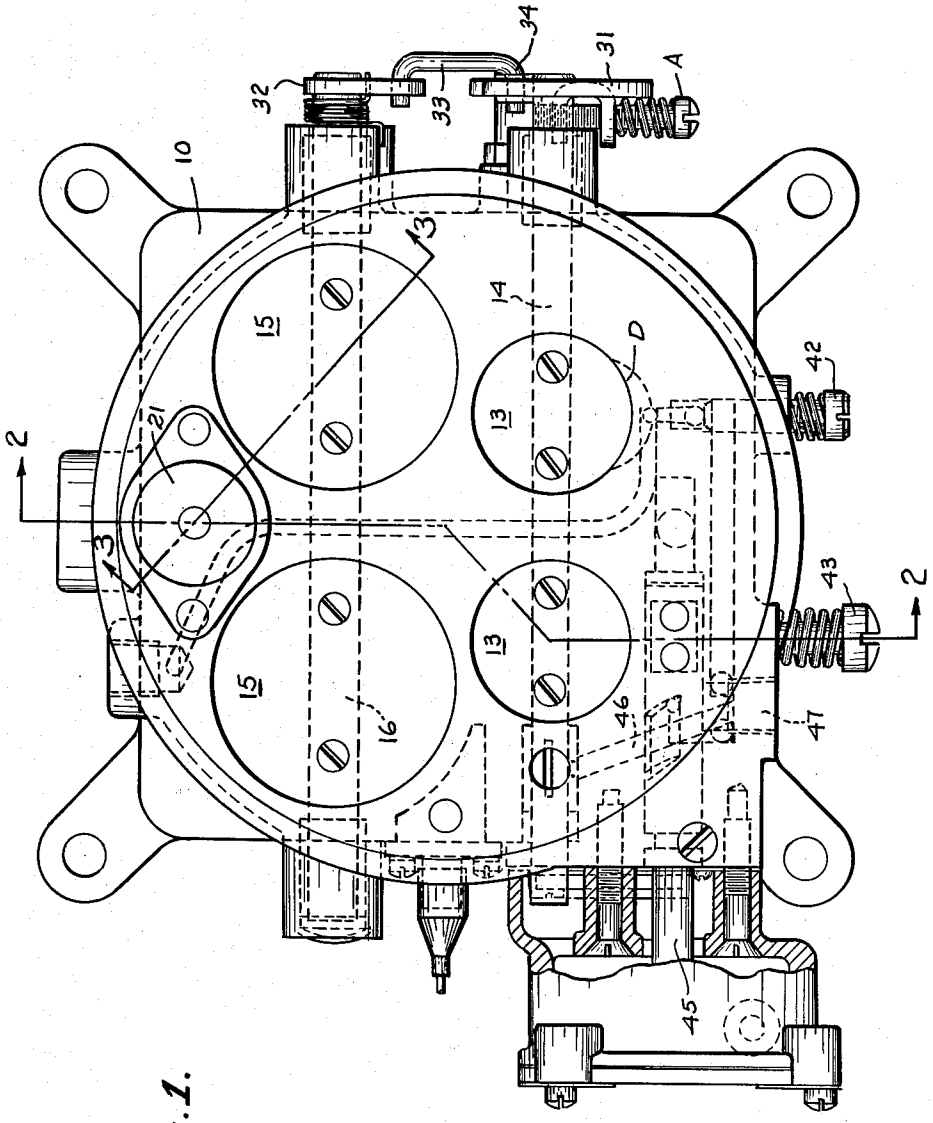

Fig. 1.

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FUEL INJECTION APPARATUS

Filed March 12, 1957 6 Sheets-Sheet 2

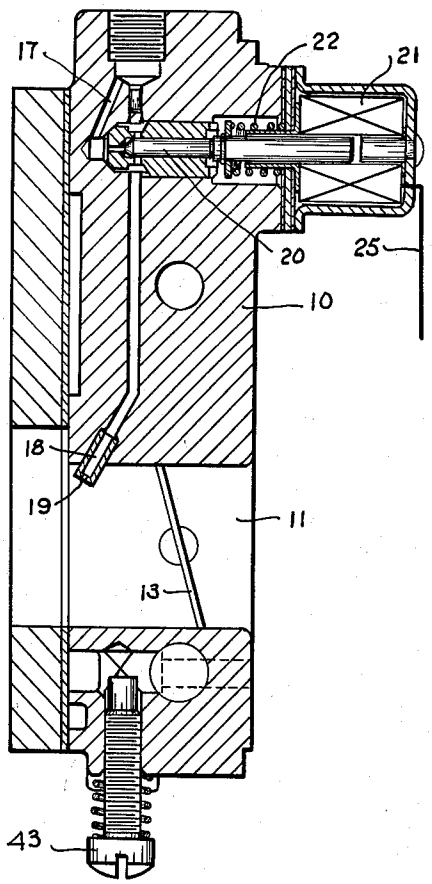

Fig. 2.

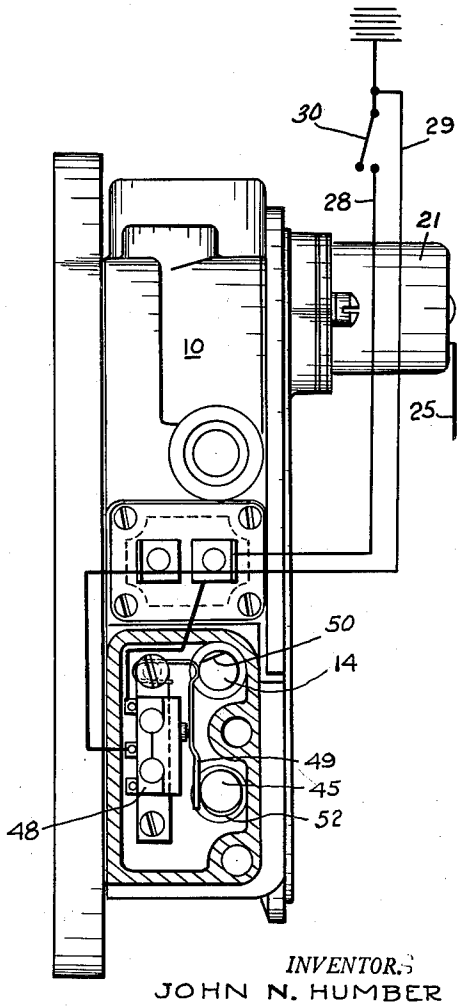

Fig. 3.

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FUEL INJECTION APPARATUS

Filed March 12, 1957 6 Sheets-Sheet 3

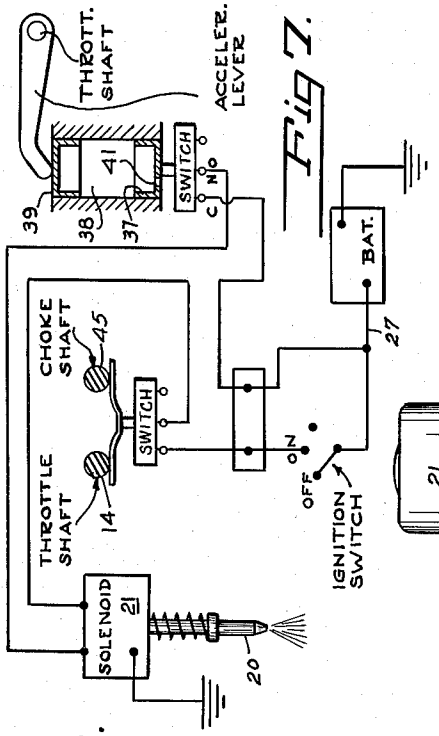

Fig. 7.

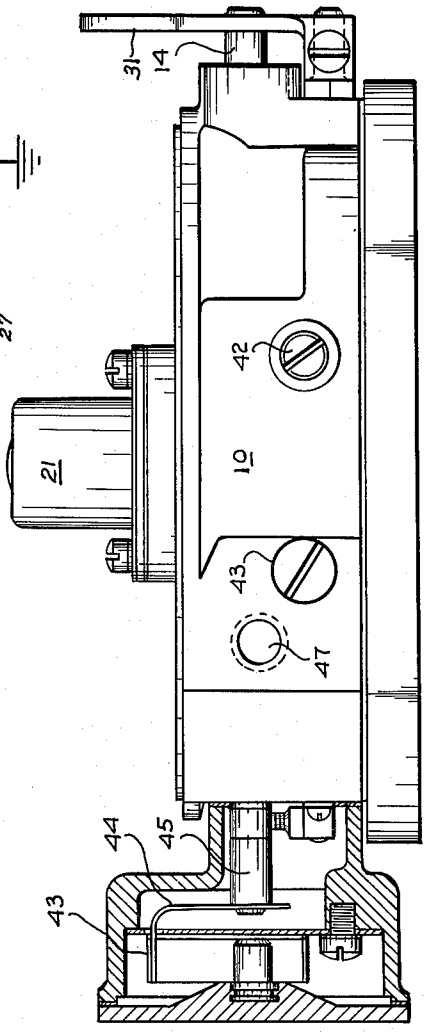

Fig. 4.

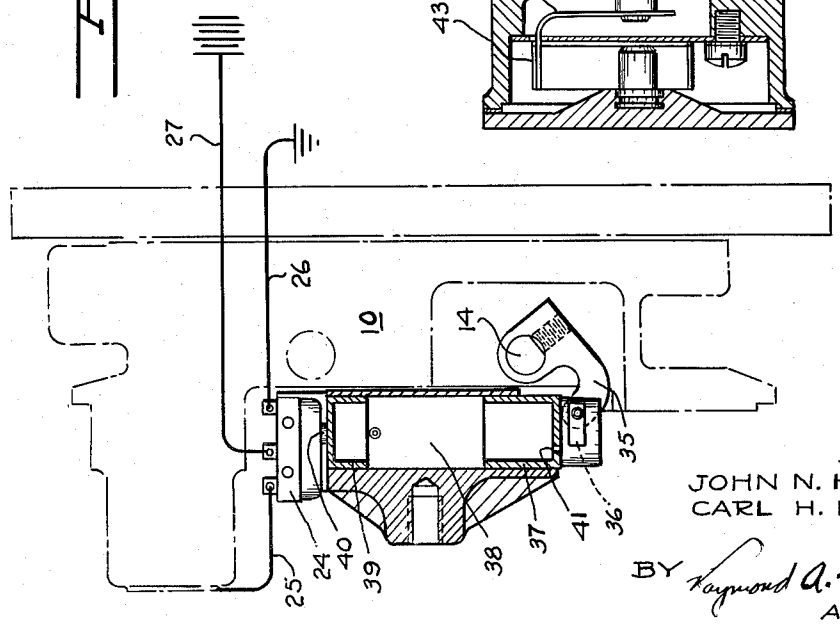

Fig. 6.

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FUEL INJECTION APPARATUS

Filed March 12, 1957 6 Sheets-Sheet 4

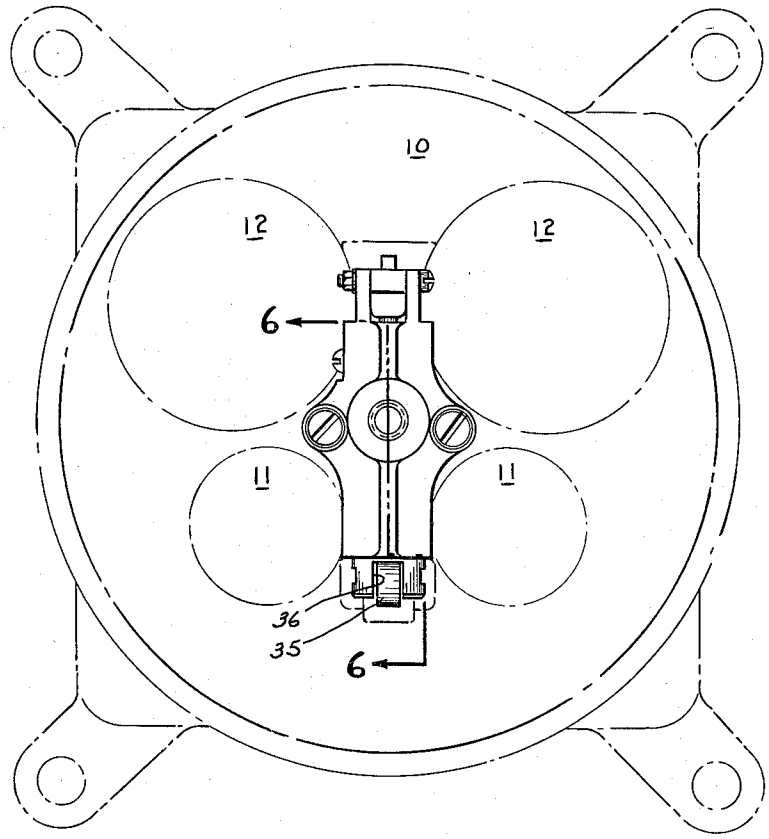

Fig. 5.

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FUEL INJECTION APPARATUS

Filed March 12, 1957 6 Sheets-Sheet 5

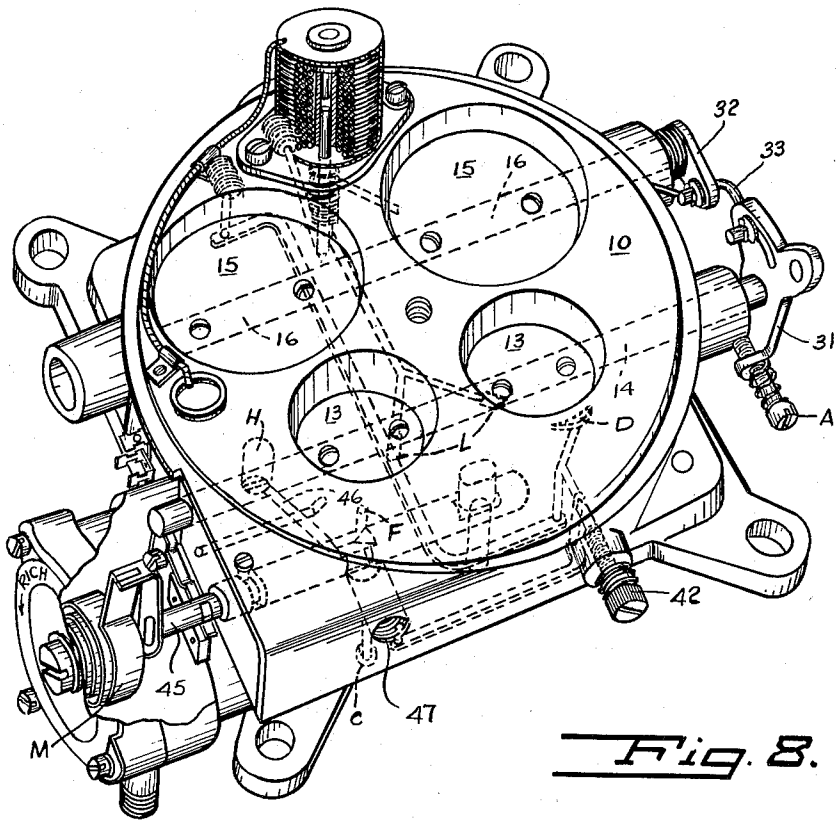

Fig. 8.

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FUEL INJECTION APPARATUS

Filed March 12, 1957 6 Sheets-Sheet 6

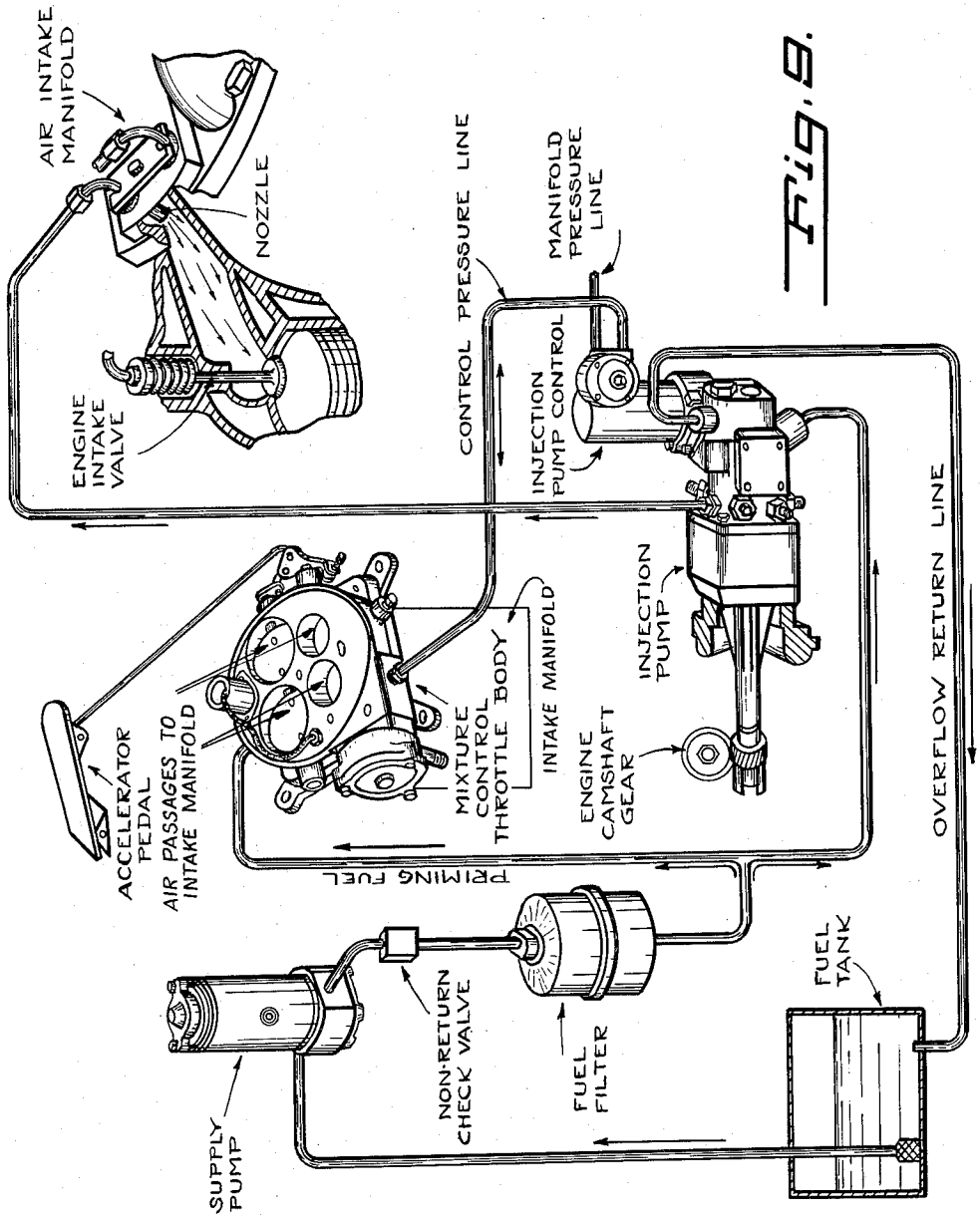

Fig. 9.

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United States Patent Office 2,989,044 Patented June 20, 1961

2,989,044

FUEL INJECTION APPARATUS

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Filed Mar. 12, 1957, Ser. No. 645,603
6 Claims. (Cl. 123—119)

This invention relates to fuel injection apparatus for spark ignition type internal combustion engines.

An object of the invention is to provide a new and improved throttle body for fuel injection apparatus of the type set forth having means for providing additional fuel for starting and for acceleration and for fuel enrichment for cold operation.

Another object is to provide a new and improved apparatus of the type set forth which is relatively simple and economical in construction, yet efficient in operation.

Other objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings. It will be understood that changes and alterations may be made in the details of construction and arrangement of parts without departing from the scope of the invention, as set forth in the accompanying claims, as the preferred forms have been given by way of illustration only.

Referring to the drawings:

FIG. 1 is a top or plan view of a throttle body constructed according to the invention;

FIG. 2 a sectional view taken on line 2—2 of FIG. 1, looking in the direction of the arrows;

FIG. 3 is a sectional view taken on line 3—3 of FIG. 1, looking in the direction of the arrows;

FIG. 4 is an end view, partially in section, of the apparatus shown in FIG. 1;

FIG. 5 is a top or plan view generally similar to FIG. 1, but showing the accelerating apparatus;

FIG. 6 is a sectional view taken on line 6—6 of FIG. 5, looking in the direction of the arrows;

FIG. 7 is a schematic wiring diagram of the electrical system embodied in the invention;

FIG. 8 is a schematic perspective view of the throttle body; and

FIG. 9 is a schematic view of a fuel injection system embodying the throttle body of the present invention.

Referring more particularly to the drawings, wherein similar reference characters designate corresponding parts throughout, the device shown embodying the invention comprises a throttle body 10 having a pair of air passages 11 and a second pair of air passages 12 extending therethrough and adapted to supply air to the intake manifold of the engine.

The passage of air through the air passages 11 to the engine intake manifold from which it passes to each of the engine cylinders is adapted to be controlled by blades 13 secured on shaft 14 which is positioned in housing 10, and the passage of air through air passages 12 is adapted to be controlled by blades 15 carried by shaft 16 extending through housing 10.

The passages 11 are shown smaller than the passages 12, but the relative size of these passages may be varied if desired.

For normal operation, fuel is injected into the intake manifold of the engine through nozzles positioned adjacent

each of the intake valves and to which nozzles fuel is supplied through a suitable fuel injection pump, as shown in Patent No. 2,772,668.

For additional fuel for priming or starting purposes and for acceleration, a fuel passage 17 in throttle body 10 is adapted to be connected by a supply line, not shown, to a fuel supply pump, which is also not shown, and passage 17 communicates with one of the air passages 11 beneath a blade 13, and the end of passage 17 is a controlled area by the member 18 having the restricting orifice 19.

For controlling the passage of fuel through fuel passage 17, there is provided the solenoid actuated valve member 20 adapted to be actuated to open position by solenoid 21 and to be closed, when the solenoid is deenergized, by means of valve spring 22.

The valve is provided with the leakoff passage 23 which allows the draining off of any fuel which might pass by valve member 20.

The energization of solenoid 21 is controlled by switch 24, which is connected to solenoid 21 by lead 25, to ground by lead 26 and to the battery by lead 27, and switch 24 is connected by leads 28 and 29 to the engine starter circuit, whereby upon closing of starter switch 30, the solenoid 21 is energized to open valve 20 to allow fuel to enter passage 11 through fuel passage 17 and, when the engine is started and starter switch 30 is opened, the furnishing of fuel through passage 17 is discontinued, except for acceleration and enrichment for cold operation as hereinafter described.

Shaft 14, which carries blades 13 for air passages 11, is provided with lever 31 to which is connected the throttle linkage from the throttle pedal, whereby actuation of the throttle pedal will actuate shaft 14 and thereby actuate blades 13 to control the air intake to the engine.

The shaft 16 is provided with the lever 32 which is operatively connected to lever 31 by link 33. Link 33 has its end 34 in a slot in lever 31, whereby lever 31 and shaft 14 may be rotated a desired amount before picking up and rotating shaft 16, for example, shaft 14 may be rotated the first thirty degrees without rotating shaft 16 and, therefore, the blades 15 would only be used for high speed operation and acceleration.

On shaft 14 is provided a bellcrank 35 which has its free end connected in a slot 36 in plunger member 37 in dashpot 38, which is provided with the slidable member 39 adapted to engage and actuate control button 40 for switch 24.

Plunger member 37 has a restricted bleed 41.

It will be seen that upon rapid depression of the throttle pedal that plunger 37 will be moved rapidly in dashpot 38 and the pneumatic force created by this movement will cause member 39 to actuate control button 40 for the switch, which will thereby effect energization of the solenoid 21, and, unless the throttle pedal is continually rapidly depressed, bleed 41 will allow the release of pressure from dashpot 38 and thereby allow member 39 to resume its normal position and release control 40 and thereby deenergize solenoid 21 to thereby allow valve 20 to close off passage 17 and prevent further flow of fuel into passage 11.

The throttle body is provided with the idle adjustment or enrichment screw 42 and fast idle adjustment screw 43, which controls the passage of the fuel into passage 11

to thereby control the idle and fast idle operation of the engine.

For cold enrichment there is provided on the side of the throttle body a thermostatic or bimetallic coil spring **43**, which is connected by lever **44** to modulating rotary valve or choke **45**, which is adapted, at other than normal temperatures, to allow atmospheric air to bleed through passage **46** and a line connected to fitting **47** to the control piston for the fuel injection pump to raise the pump setting at loads above idling to higher delivery during engine warmup.

A second switch **48** is provided adjacent shafts **14** and **45** for controlling the energization of solenoid **21** to allow the supply of extra fuel through passage **17** at such time, and the operation of this second switch **48** is controlled by member **49**. This second switch is hooked in the primary circuit, that is, in series with the starter circuit.

Shaft **14** is provided with the cam or flat surface **50**, whereby when the engine is flooded, the depressing of the throttle pedal to wide open throttle position rotates the cam surface **14** over the adjacent position of spring **49** and allows the switch to deenergize the priming circuit, thereby preventing further priming until the throttle pedal is released.

On shaft **45** is provided the cam **52**, whereby when shaft **45** is rotated through the bimetallic or thermostatic spring **43**, spring **49** will engage the actuating button on switch **48** and thereby effect energization of solenoid **21** to provide further fuel enrichment for such cold operation, and when the engine reaches normal operating temperature, shaft **45** will be rotated to a position whereby cam portion **52** will not engage spring **49** and switch **48** will then open to deenergize solenoid **21**, and discontinue such supply of additional fuel.

The mixture control contains the conventional throttle blades **13** and **15** of a carburetor system which are operated by the accelerator pedal and adjusted for idle speed by idle adjustment screw A. Air passes through the openings controlled by the blades to the engine intake manifold.

As the system operates to a speed-density principle, the control pressure which operates the pump control is basically manifold pressure throughout the entire range, except at idle and during cold operation. A control pressure chamber or fitting **47** receives manifold pressure through duct C and feeds the pressure to the injection pump control. During idle, a richer mixture is required to compensate for exhaust gas dilution. A slot D above the throttle blade at idle position bleeds intake air pressure to the control chamber and raises the control pressure for a richer pump setting. At above idle position, the throttle blade edge rises above the idle slot, the slot becomes manifold pressure, and idle adjustment screw **42** has no effect on the engine mixture.

A cold engine requires excess fuel during the warmup period with enrichment gradually tapering off as the engine approaches normal operating temperature. Since the pump meters to a control pressure curve, the control pressure must be raised to increase the pump delivery. This is accomplished as follows:

A drilled orifice F connects the control pressure chamber **47** to atmosphere and is closed by modulating valve **45** during normal operation. The valve **45**, operated by thermo responsive element M, is rotated during cold operation so that the orifice F is uncovered. This feeds atmospheric pressure to the control pressure chamber and raises the control pressure to a higher value. An auxiliary orifice H is uncovered by the throttle shaft at above idle setting and supplements the original orifice F. This variable orifice is required to maintain a constant differential between manifold pressure and control pressure throughout the entire operating range. As the engine warms up, the modulating valve **45** is rotated gradually by thermostatic member M until both bleeds F and H are closed.

In order to insure good cold starting of the engine, a fuel flow two to three times full load value is required and, as soon as the ignition key is turned on, supply pressure is available and this convenient source of pressurized fuel is utilized for priming. The solenoid operated valve **20**, energized by the starter circuit, controls the priming fuel which is sprayed into the manifold through jets L located in each of the primary barrels **13**.

During hot re-starts and in the event of flooding, it is desirable to cut off the flow of priming fuel. A small movement switch N, connected in series in the priming circuit, is actuated by arm O, which contacts integral cams on throttle shaft **14** and modulating shaft **45**, respectively. When either the throttle blades are rotated to wide-open position or the modulating valve is rotated to warm operation position, the switch is opened and priming fuel flow is cut off.

In operation, upon rapid depression of the throttle pedal, plunger **37** will be moved rapidly in dashpot **38** and this will cause member **39** to actuate the throttle button **40** for the switch and thereby effect energization of solenoid **21**, and unless the throttle pedal is continually rapidly depressed, the bleed **41** will allow the release of pressure from dashpot **38** and allow member **39** to resume its normal position and release control **40** to deenergize solenoid **21** to allow valve **20** to close off passage **17** and prevent further flow of fuel into passage **11**.

For cold operation, spring **43**, which is connected by lever **44** to valve **45**, will allow atmospheric air to bleed through passage **46** and a line connected to fitting **47** to the control piston for the engine pump to raise the pump setting at loads above idling to higher delivery during engine warmup.

From the foregoing it will be seen that we have provided new and improved means for obtaining all of the objects and advantages of the invention.

We claim:

1. In a device of the character described, a fuel passage, a solenoid actuated valve controlling the passage of fuel through said fuel passage, a solenoid for actuating said valve, a switch for controlling the energization of said solenoid and control means for actuating said switch, said means including a dashpot, a throttle linkage for actuating said dashpot, and means connecting said dashpot to a throttle linkage for causing said dashpot to actuate said switch upon rapid movement of said throttle linkage.

2. In a device of the character described, a fuel passage, a valve for controlling the passage of fuel through said fuel passage, solenoid means operatively connected to said valve for actuating said valve, a switch for controlling the energization of said solenoid means and connected to a linkage for actuating said switch, said means including a dashpot and means for causing said dashpot to actuate said switch upon rapid movement of the linkage.

3. In a device of the character described, a throttle body having air passage means therethrough, a shaft, blade means carried by said shaft for controlling the passage of air through said air passages, a passage adapted to be connected to a fuel control and thermostatically controlled valve means for controlling the passage of air to said fuel control.

4. In a device of the character described, a throttle body having air passage means therethrough, a shaft, blade means carried by said shaft for controlling the passage of air through said air passages, a passage adapted to be connected to a fuel control and thermostatically controlled valve means for controlling the passage of air to said fuel control, said thermostatically controlled means comprising a thermostatic element and a rotary valve operatively connected to said thermostatic element and adapted to be actuated thereby.

5. In a device of the character described, a throttle body having air passage means therethrough, a shaft, blade means carried by said shaft for controlling the passage of air through said air passages, a passage adapted to

be connected to a fuel control and thermostatically controlled valve means for controlling the passage of air to said fuel control, a fuel passage, a solenoid actuated valve for controlling the passage of fuel through said fuel passage, a switch for controlling the energization of said solenoid, a second switch and means actuated by said throttle shaft for controlling the operation of said second switch.

6. In a device of the character described, a throttle body having air passage means therethrough, a shaft, blade means carried by said shaft for controlling the passage of air through said air passages, a passage adapted to be connected to a fuel control and thermostatically controlled valve means for controlling the passage of air to said fuel control, said thermostatically controlled means comprising a thermostatic element and a rotary valve operatively connected to said thermostatic element and

adapted to be actuated thereby, a fuel passage, a solenoid actuated valve for controlling the passage of fuel through said fuel passage, a switch for controlling the energization of said solenoid, a second switch and means actuated by said throttle shaft for controlling the operation of said second switch, and means controlled by said thermostatically controlled valve for controlling said second switch.

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