

[54] CARBURETOR SYSTEM HAVING A FLUIDIC PROPORTIONAL AMPLIFIER

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[58] Field of Search.....261/36 A, 69, DIG. 69; 123/119 R, DIG. 10; 137/81.5

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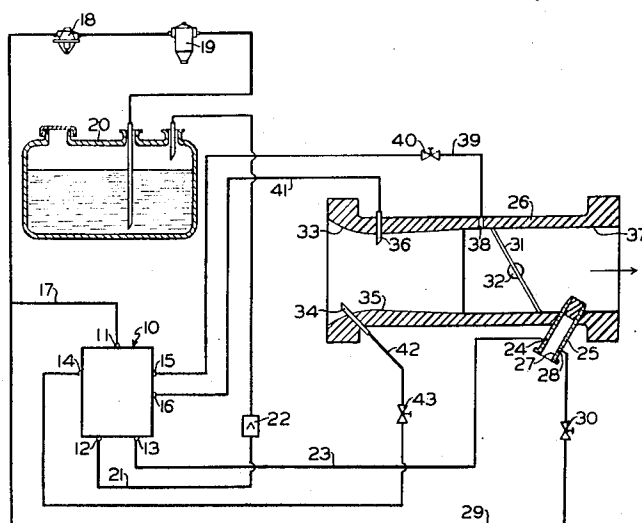
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[57] ABSTRACT

A carburetor having a fluidic proportioning device adapted to deliver fuel to an air-intake conduit in proportion to air pressure differential established across the control ports of the fluidic device by regions of different pressures established within the venturi shape of the air-intake conduit and the variable position of a throttle valve, the fluidic proportioning device including a first control port responsive to air pressure in an enlarged portion of the air-intake conduit, a second control port opposing the first control port and responsive to low air pressure in that portion of the air-intake conduit restricted by the throttle plate at low engine speeds and a third control port additively connected to the second control port and responsive to pressure within a narrow portion of the air-intake conduit.

3 Claims, 6 Drawing Figures



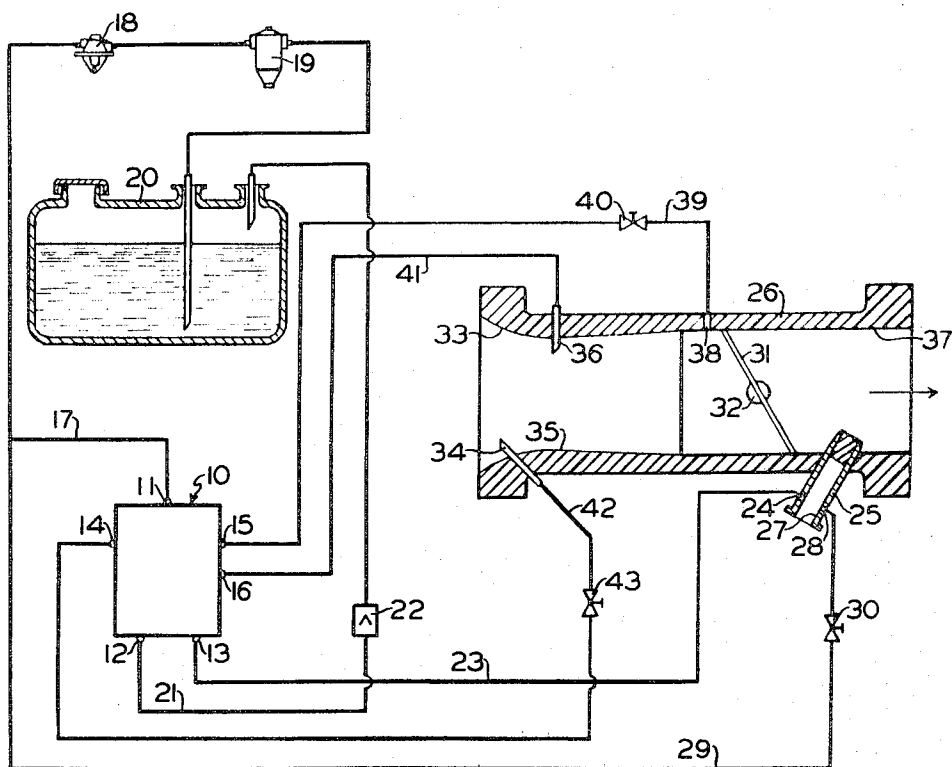


FIG. 1

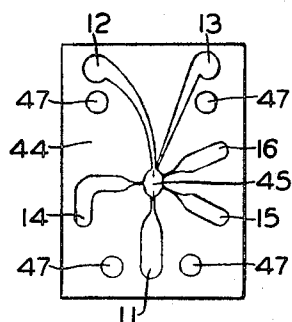


FIG. 2

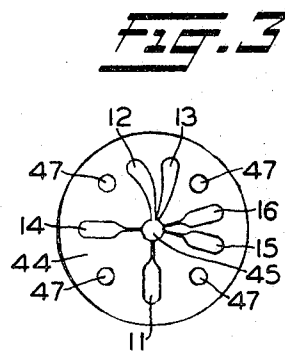
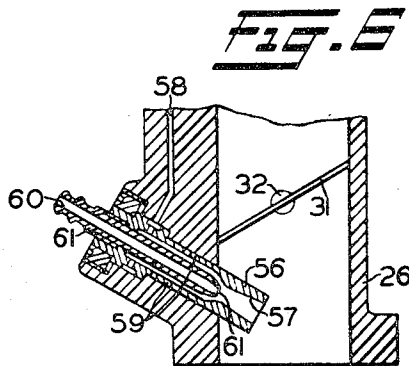
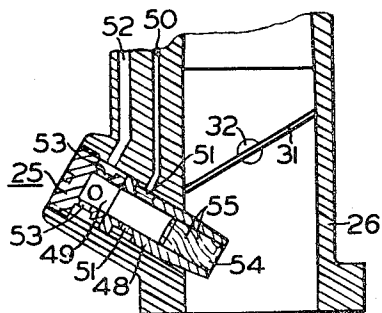
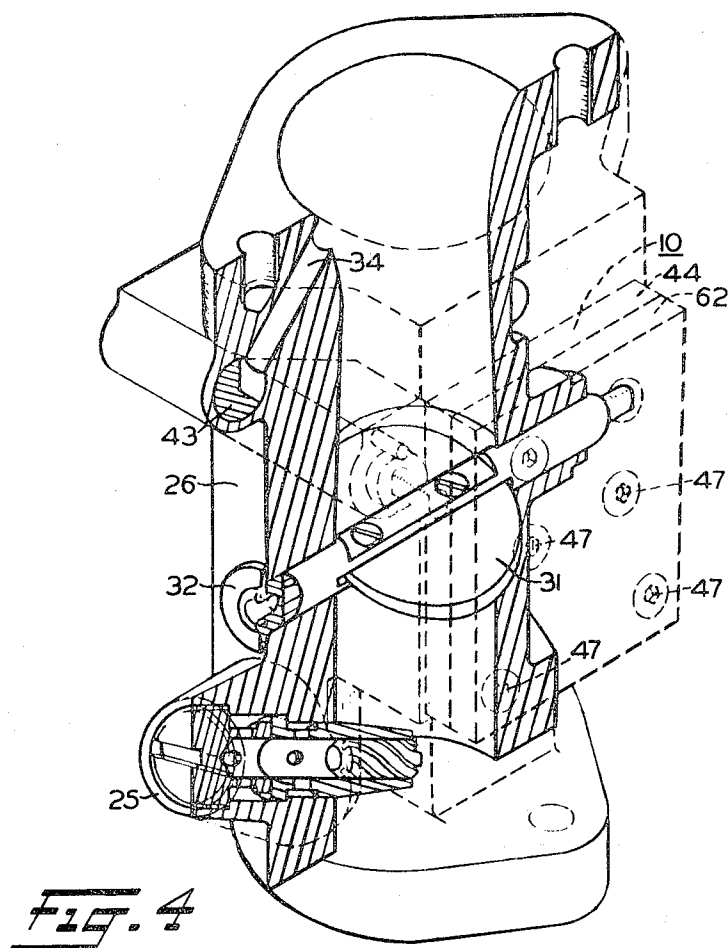


FIG. 3

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CARBURETOR SYSTEM HAVING A FLUIDIC PROPORTIONAL AMPLIFIER

BACKGROUND OF INVENTION

The prime purpose of a carburetion system is to mix a proportioned quantity of gasoline with air drawn in by the engine so as to assure a proper air to gasoline mixture for each rotational speed and load condition of the engine. Present carburetion systems, especially those used in automobiles, and with the exception of a few complicated mechanical and electronic devices, achieve air to gasoline proportioning by direct injection of the gasoline into the engine in response to the vacuum which occurs in the air-intake conduit of the engine. The vacuum condition is conventionally increased by contouring the interior of the intake conduit in the form of the familiar venturi tube.

The above principle of operation of the conventional carburetor is fairly simple in theory but, in practice, it has been found impossible to achieve optimum air-to-gasoline mixture for each rotational speed and load condition of the engine, unless expensive and highly complicated corrective apparatus is added to the carburetor device. Moreover, partial filling of the engine cylinders occurs at high engine speeds due to the narrower portion of the venturi-shaped air-intake conduit and the locations of the jets or nozzles relative thereto.

In my Italian Patent 824,478, filed Feb. 16, 1968, the above disadvantages of conventional carburetion systems were eliminated by providing an indirect injection carburetion system which did not directly utilize the air stream in the intake conduit to draw fuel from the nozzle into the mixing area, but, instead, utilized a means sensitive to the pressure differential existing between the atmosphere and the air-intake conduit of the engine for controlling gasoline under pump pressure, so as to proportion the quantity of fuel delivered to the fuel nozzle. The means so utilized was a pure fluid amplifier, having no moving parts, which delivered fuel from a fuel tank through a fuel pump to a fuel nozzle in the mixing area in proportion to the pressure differential across the control ports of the amplifier as provided by the pressure differential between a pair of feelers, one subjected to atmospheric pressure, and the other disposed in the venturi tube and subjected to the lower air pressure produced by the air flow through the venturi tube. A spring-biased throttle valve or plate, disposed in the air-intake conduit axially between the feelers provided an additional pressure differential for efficient operation at low engine speeds. By that construction, there was proposed a carburetion system very simple to manufacture, very quick to respond to acceleration, easy to enlarge to suit every type of internal combustion engine, and one which provided for the elimination of delicate devices such as the constant level float, the acceleration pump, adjustable nozzles, needle valves, diaphragms and bellows and interconnecting apparatus.

Although the aforementioned pure fluid amplifier, as controlled by pressure differential between atmosphere and pressure within the venturi tube is effective to proportion delivery of fuel to the air-intake conduit in accordance with various engine speeds and load conditions, the lower pressure within the venturi tube, as controlled by the venturi shape and air flow therethrough, is modified to some degree by the flow of air past an auxiliary throttle valve or plate disposed in the air-intake conduit axially between the feelers to add a pressure differential to the venturi induced pressure differential to provide efficient operation of the proportional amplifier at low engine speeds, which throttle plate is spring biased to remain partially closed during engine start-up and thereafter opens an amount proportional to the air flow through the air-intake conduit. Accordingly, the air pressure in the air-intake conduit is controlled simultaneously by the venturi tube and the upstream throttle plate so that as the engine speed increases and the effect of the throttle plate gradually decreases, the feelers in the venturi tube detect the venturi induced pressure as modified by the presence of the throttle plate, resulting in a pressure differential deviation preventing optimum air to gasoline mixture, particularly at the higher engine speeds.

SUMMARY OF INVENTION

Accordingly, it is an object of this invention to eliminate the aforementioned throttle plate and to provide in a carburetion system a fluidic proportioning device for proportionally delivering fuel to an air-intake conduit in accordance with optimum control pressure differentials established between different pressure regions in the air-intake conduit depending upon the speed of the engine.

In the present invention, this object is achieved by the utilization of a particular fluidic proportioning device in which a first control pressure port is opposed by a pair of additively communicated control ports carrying second and third control pressure ports. The first control pressure port is communicated with an enlarged portion of the interior of the air-intake conduit to provide the basic pressure reference, the second control pressure port is communicated with the interior of the air-intake conduit adjacent a throttle plate primarily to sense the low pressure at that location due to conduit restriction by the throttle plate in the engine starting and low speed range of engine operation, and the third control pressure port is communicated with a narrowed portion of the air-intake conduit primarily to sense the low pressure present at that location in the high speed range of operation. Since the pressure differential between the first and second control input ports is greatest for low-speed air flow through the conduit and proportionally diminishes to a negligible factor with increasing air flow commensurate with greater throttle opening at higher speeds, and since the pressure differential between the first and third control pressure ports is negligible at lower engine speeds and proportionally increases with increase in engine speed, the sum of two differentials provides, in opposition to the first control pressure port, a pressure differential on the fuel stream passing through the fluidic proportioning device, which pressure differential increases in proportion to air flow through the air-intake conduit to deliver to the air-intake conduit an amount of fuel proportional to engine demand for air for all engine speeds.

This and other objectives will become more readily apparent in the following description, taken in conjunction with the drawing, in which:

FIG. 1 is a schematic diagram of a carburetion system showing my invention;

FIG. 2 is a plan view of an element of the fluidic proportioning device shown in FIG. 1;

FIG. 3 is a plan view of an element of a second embodiment of a fluidic proportioning device;

FIG. 4 is a perspective view, taken partly in section of a practical embodiment of a portion of the carburetion system of FIG. 1;

FIG. 5 is a sectional view of one embodiment of the fuel injector nozzle generally shown in FIG. 1; and

FIG. 6 is a sectional view of a second embodiment of the fuel injector nozzle generally shown in FIG. 1.

Referring now to FIG. 1 of the drawing, there is shown a carburetion system including, as the prime fuel regulator, a fluidic proportioning device 10, sometimes referred to as a fluid amplifier, comprising a supply port 11, a pair of outlet ports 12 and 13, and three regulatory control pressure ports 14, 15 and 16. The supply port 11 communicates, via a pipe 17, filter 18 and fuel pump 19, with a fuel tank or reservoir 20. The output or discharge port 12 also communicates with reservoir 20 via pipe 21, and check valve 22.

Output or discharge port 13 is communicated via pipe 23 to a peripheral inlet 24 of a fuel injector or nozzle 25 mounted in and communicating with the interior of an air-intake conduit 26 by which air is taken into an internal combustion engine, not shown, in the direction of the arrow. The injector 25 is also provided with an air inlet 27, and an additional peripheral fuel inlet 28 communicating with pipe 17 via branch pipe 29 and an adjustable regulating valve 30.

The aforementioned air-intake conduit 26 is of a generally tubular form and includes near the inlet end thereof a venturi configuration hereinafter described in detail, and further in-

cludes in the intermediate portion thereof a conventional throttle plate or valve 31, mounted for rotation on a pivot 32 in response to movement of a conventional accelerator pedal, not shown.

The air-intake conduit has an internal configuration comprised of three prime axial regions, which are, a diametrically enlarged region 33 at the inlet end of the conduit including a pressure sensing tube 34, a diametrically narrowed region 35, disposed adjacent region 33 and including a pressure sensing tube 36, and a cylindrical region 37 adjacent the region 35 and including a pressure sensing port 38 disposed adjacent the edge of the throttle plate 31 so that, as the throttle begins to open, the port 38 is disposed adjacent to the small opening between the periphery of the plate and the cylindrical wall, for reasons hereinafter described in detail.

The pressure sensing tube 38 is connected via pipe 39 and regulating valve 40 to the control pressure port 15 of the fluidic proportioning device 10. The pressure tube 36 is connected via pipe 41 to control pressure port 16 of the fluidic proportioning device 10. The pressure sensing tube 34 is connected by means of pipe 42 and regulating valve 43 to control pressure port 14 of the fluidic proportioning device 10.

Referring now to FIGS. 2 and 3 of the drawing, there are shown two separate embodiments of fluidic proportioning device 10 which are internally identical, the same parts being identified by the same reference numerals on corresponding parts of the fluidic proportioning device of FIG. 1. FIG. 2 differs from FIG. 3 primarily in the external configuration, FIG. 2 being rectangular and FIG. 3 being circular.

Referring now to FIG. 2 in particular, it will be seen that the fluidic proportioning device comprises a plate 44 having disposed on the surface thereof a plurality of grooves 11, 12, 13, 14, 15 and 16 corresponding to the ports previously identified in the description of FIG. 1 above, all communicating with a semi-cylindrical groove 45. A second plate, not shown, includes a plurality of holes each registering with one of the ports. The holes 47 on plate 44 are used to fix thereto the second plate in any suitable manner, as by screws, not shown.

As can be seen in FIG. 2, the supply port 11 communicates with chamber 45 via a groove disposed opposite a groove communicating outlet port 12 with chamber 45, the groove of supply port 11 being aligned with the groove of outlet port 12. On the same side of chamber 45 as the groove for outlet port 12, but slightly displaced with respect to the axis of the groove of supply port 11, the groove for outlet port 13 communicates with chamber 45 for ultimate communication with the fuel injector 25 of FIG. 1. At the sides of chamber 45, the grooves corresponding to control ports 15 and 16 are arranged on the same side of chamber 45 relative to outlet port 13 with respect to the center line of chamber 45, while the groove of control port 14 is disposed on the side of chamber 45 opposite the grooves of control ports 15 and 16.

In now describing the operation of the carburetion system of FIG. 1, it will be observed that during engine starting the pressure differential between pressure sensing tubes 34 and 36, and between pressure sensing tube 34 and pressure sensing port 38 is practically non-existent so that substantially zero pressure differential is provided across the chamber 45 of the fluidic proportioning device 10. Accordingly, substantially all the fuel supplied from reservoir 20 to supply port 11 passes through chamber 45 to outlet port 12 for return through pipe 21 and check valve 22 to reservoir 20.

Now assuming that the engine has started and is in the idle condition, fuel supply through fuel injector 25 to the air-intake conduit 26 and the engine is sustained from reservoir 20 through pipe 29 and regulating valve 30.

Now assuming that the throttle plate or valve 31 begins to open to effect increase in air flow through conduit 26 and thereby increase engine speed, the pressure within the conduit 26 generally decreases commensurate with increased air flow therethrough, thereby initially increasing the pressure differential between pressure sensing tube 34 and port 38 and

thereafter, between the venturi responsive pressure sensing tubes 34 and 36.

In the first instance, at low engine speeds, the low pressure differential within the conduit produces only a slight deviation of the fluid stream and does not produce substantial air-to-fuel mixing in the conduit, with the advantage of producing only low emulsions, thus maintaining the fuel stream in a laminar flow condition and balancing the pressure differential between the opposite sides of chamber 45 with resulting centrifugal forces caused by the deviation.

In the initial phase of low engine speed, the pressure differential between tubes 34 and 36 is negligible because of low venturi effect at low speed air flow. However, inasmuch as pressure sensing port 38 is substantially within the relatively high speed air flow around the periphery of slightly opened throttle plate 31, thus producing in port 38 a low pressure relative to pressure in tube 34, a corresponding pressure differential is produced across control ports 14 and 15 to deviate a proportional amount of the fluid stream into output 13 for delivery to the fuel injector 25.

As the throttle opens, thus widening the space between the periphery of plate 31 and the wall of cylinder portion 37, the pressure differential between tube 34 and port 38 lessens, while at the same time, the increased air flow in the conduit increases the pressure differential between pressure sensing tubes 34 and 36 due to the venturi shape of the conduit. Tube 34 may be open to upstream pressure while tube 36 may be open to downstream pressure, as shown in FIG. 1, to add a further pressure differential to the venturi induced pressure differential. With increased speed, the fuel stream through chamber 45 is further deviated to output 13 to proportionally increase the quantity of fuel injected into the conduit 26 for attaining the required number of engine revolutions per unit of time.

Regulating valves 43 and 40 are adjustable to provide initial setting of the fluidic proportioning device and a predetermination of the point at which the engine stops idling.

Check valve 22 presents return of fuel to the fluidic proportioning device 10 when the engine is stopped.

Referring now to FIGS. 5 and 6, there are shown two examples of fuel injectors or nozzles in accordance with another aspect of the invention.

Referring particularly to FIG. 5, there is shown a cylindrical element 48 connected in the air-intake conduit 26, and including an inner chamber 49 supplied with fuel through a pipe 50, which may be connected to both pipes 29 and 23 of FIG. 1, and four orifices 51, only two shown. Air is communicated with chamber 49 via pipe 52 and four orifices 53, only two shown, corresponding to orifice 27 of FIG. 1. At the outlet of chamber 49 there is disposed a plug element 54, the exterior of which includes a plurality of helical end-to-end grooves 55 through which passes the air-fuel mixture, creating a centrifugally induced circular jet entering the air-intake conduit 26.

Referring now to FIG. 6, the fuel injector comprises a cylindrical element 56 including a divergent chamber 57 into which fuel is injected via intercommunicated conduits 58 and 59, the former communicated with pipes 23 and 29 of FIG. 1. Air is supplied via passage 60 in a nozzle 61 opening at one end to atmosphere and opening at a convergent portion 61 at the other end to chamber 57. Fuel is forced into the air-intake conduit by air in conduit 60 drawn through convergent portion 61 by the reduced air pressure present in the narrow portion of chamber 57.

Referring now to FIG. 4, there is shown a practical embodiment of a portion of the carburetion system of FIG. 1, showing a unitary air-intake conduit and fluidic proportioning device mounted thereon.

Those elements of FIG. 4 corresponding to elements shown in FIGS. 1 through 6 have been assigned the same reference numerals for easy identification and location of parts. In this embodiment, the plate 44 of the fluidic proportioning device is mounted directly upon the air-intake conduit 26, the latter being provided with suitable orifices, not shown, for commu-

nicating the various parts of the fluidic device with the pressure sensing tubes 34, 36, pressure sensing port 38, the fuel injector 25 and the fuel reservoir 20. Backing plate 62 is utilized to apply proper holding pressure against plate 44.

Having now described the invention, what I claim as new and desire to secure by Letters Patent, is:

- 1. A fuel system for an internal combustion engine, comprising:
 - a. an air-intake conduit having a diametrically enlarged portion at the intake end and a diametrically narrowed portion downstream of said enlarged portion for producing in the conduit a pressure differential varying with the rate of air flow through the conduit,
 - b. a fuel reservoir,
 - c. a fuel line,
 - d. means for pumping fuel from said reservoir through said fuel line,
 - e. a fluidic proportioning device including a supply port communicated with said fuel line, a pair of output ports, and a pair of opposing control pressure input ports each communicated with a different one of said diametrically enlarged portion and said diametrically narrowed portion of said air conduit, which when differentially pressurized so that the higher pressure in the diametrically enlarged portion is applied to a predetermined one of said pair of control pressure inputs, fuel is delivered from said supply port to one of said pair of output ports in proportion to the pressure differential,
 - f. a fuel nozzle opening internally of said air intake conduit,
 - g. a delivery passage communicating said one of said pair of output ports with said fuel nozzle,
 - h. a fuel idling passage communicating said fuel line to said

- fuel nozzle, and
- i. a fuel return passage communicating the other of said pair of outputs to said reservoir.
- 2. A carburetion system, as recited in claim 1, in which said fuel nozzle includes:
 - a. a mixing chamber communicated with said fuel idling passage and said delivery passage, and
 - b. means communicating said mixing chamber with atmosphere.
- 3. A carburetion system, comprising:
 - a. an air-intake conduit having a body and a passage therethrough,
 - b. said body having a flat surface on the exterior thereof,
 - c. a fluidic proportioning device including a member having a flat surface,
 - d. a plurality of grooves in said flat surface,
 - e. said member fixedly attached to said body with said flat surface of said member engaging said flat surface of said body,
 - f. said grooves forming with said flat surface of said air-intake conduit a chamber radially communicated with a plurality of generally radially disposed passages,
 - g. said chamber comprising a stream interaction chamber,
 - h. said radially disposed passages comprising a supply passage, control pressure passages and output passages, and
 - i. a plurality of passages in said body, each opening at one end to said conduit passage and opening at the other end at said flat surface of said body in communication with a different one of said grooves.

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