United States Patent [19]

Nardi

[11] **3,751,016**

[45] **Aug. 7, 1973**

[54] **CARBURETION SYSTEM**

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[22] Filed: **Mar. 23, 1971**

[21] Appl. No.: **127,153**

[30] **Foreign Application Priority Data**

Apr. 24, 1970 Italy 68417 A/70

[52] **U.S. Cl.** .... **261/36 A,** 261/69 R, 261/DIG. 69
[51] **Int. Cl.** **F02m 69/04**
[58] **Field of Search** .... 261/DIG. 69, 36 A, 261/69 R, DIG. 67

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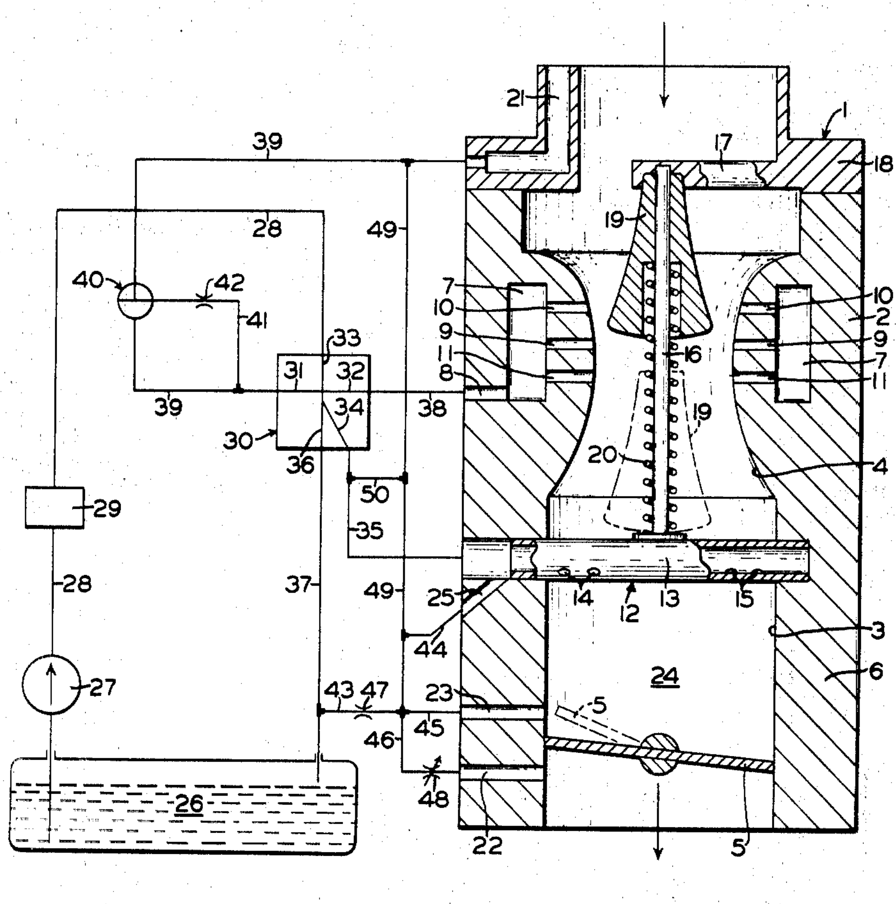
[57] **ABSTRACT**

A carburetion system including a carburetor with a venturi in the air intake passageway thereof and a fuel nozzle opening thereinto downstream of the venturi, a fluidic regulator device for effecting fuel delivery from a fuel tank to said fuel nozzle for injection into said intake passageway at a rate according to a pressure differential between atmospheric pressure and a venturi induced pressure in the intake passage impressed across the control inputs of the regulator device, said carburetor including a metering element disposed within the venturi area and being axially displaceable against biasing means from a normal position adjacent the most constricted region of the venturi throat toward the least constricted region by dynamic action of intake air flow through the intake passageway, the degree of such dynamic action and, therefore, the amount of such axial displacement of said metering element being determined by the extent to which a throttle valve disposed in the intake passageway downstream of the venturi is opened, thereby proportionally modifying the effect of pressure differential across the input controls of the regulator device.

8 Claims, 2 Drawing Figures



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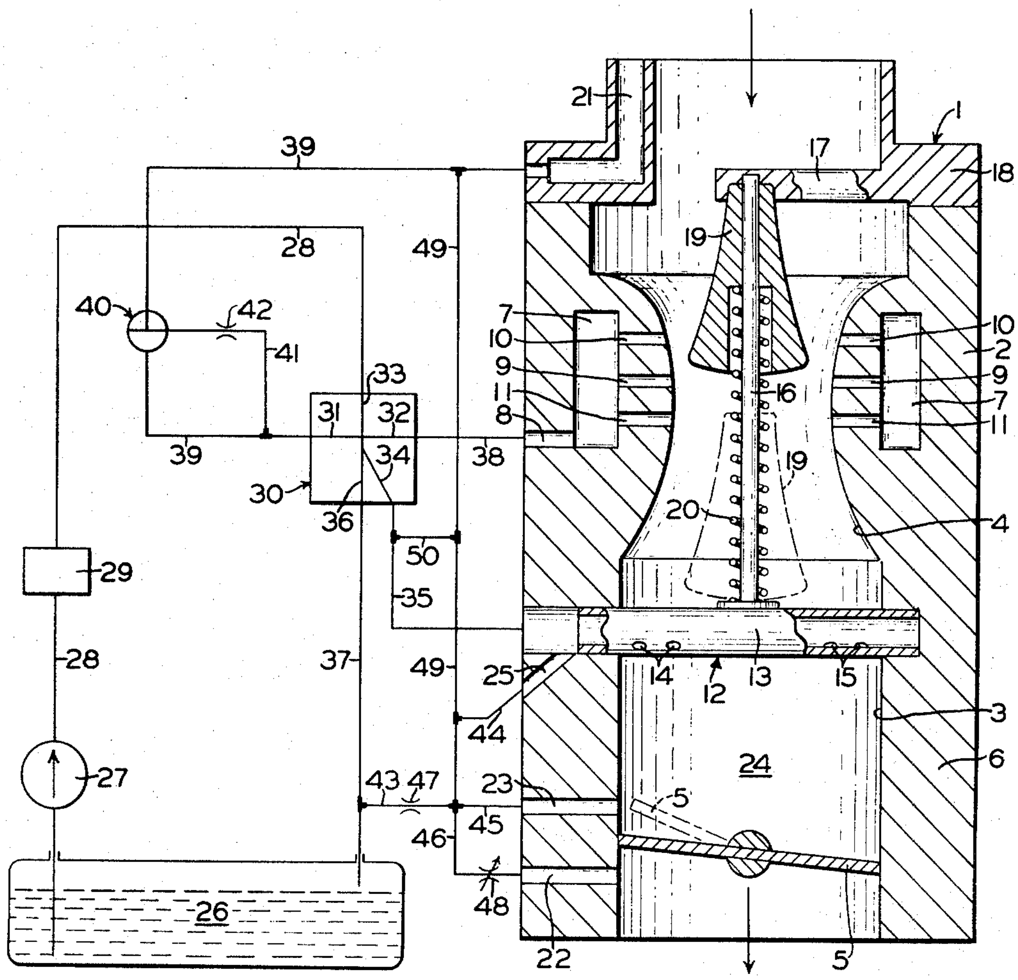

Fig. 1

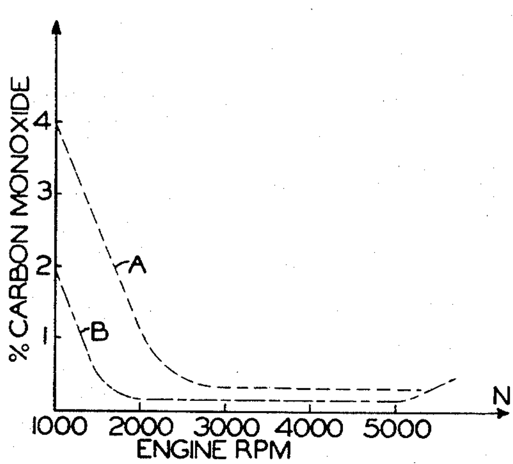

Fig. 2

CARBURETION SYSTEM

BACKGROUND OF THE INVENTION

Primarily, the function of a carburetion system is to mix, in metered proportions, gasoline with air drawn in by the engine to assure the proper fuel mixture for the rotational speed and load condition of the engine at any given time. Providing a propoer mixture of gasoline and air, particulary at higher engine speeds, becomes difficult in that the sensitivity of the carburetor to variations at higher speeds may be less efficient and, therefore, responsiveness may be hesitant. To some extent some of the presently used carburetors have overcome this problem, but, in some instances at the sacrifice of efficiency at idling speeds, which results in greater exhaust emission pollution, and in other instances by the use of very sophisticated and delicate mechanical devices such as the constant level float, the acceleration pump, adjustable nozzles, needle valves, diaphragms and bellows, and interconnecting mechanisms, all of which result in higher cost of manufacture and maintenance as well as a greater probability of malfunctioning.

SUMMARY OF THE INVENTION

Accordingly, the object of the present invention is to provide a simplified carburetor for use in a fuel supply system for an internal combustion engine, said carburetor being characterized by a fine attunement and, therefore, a maximum sensitivity of response to all variations of engine speeds to deliver, without hesitancy, the proper mixture of gasoline and air to the engine, even at idling speed, with a minimum of carbon monoxide in the exhaust gases.

The object of the invention is attained by providing the carburetor with the usual venturi in the intake passageway and a throttle valve arranged downstream of said venturi. The supply of fuel to the carburetor to be mixed with air is controlled by a fluidic regulator or amplifier responsive to an air pressure differential established across two oppositely disposed control inputs thereon to act on and thus divert a portion of a fuel stream flowing through the regulator to a channel leading to the carburetor mixing chamber, said portion of fuel thus diverted being determined by the degree of said pressure differential, which is established by subjecting one of the control inputs, say a reference input, to a reference pressure such as that at the upstream end of the carburetor, and subjecting the other control input, say a signal input, to a pressure signal from the venturi region of the carburetor.

According to the invention, several sets of passageways are disposed at different axial levels of the venturi throat with each of the several passageways having one end opening into said venturi throat with the other ends opening into a common communication leading to the signal input of the fluidic regulator for transmitting thereto a pressure impulse signal. A throttle or metering element is coaxially disposed in the venturi region of the carburetor and is axially displaceable, against opposing action of biasing means, by the dynamic action of intake air flowing through the venturi region. Axial displacement of the metering element past one or more levels of the openings of the passageways into the venturi throat affects the pressure signal at the signal input such that the degree of said pressure signal varies in accordance with the amount of axial displacement of said metering element. The extent of axial displacement of the metering element is determined by the degree of intake air flow through the venturi, which, in turn, is determined by the extent to which the throttle valve is opened.

In the accompanying drawings:

FIG. 1 is a schematic view of a fuel supply system including an elevational view, mostly in section, of a carburetor according to the invention; and

FIG. 2 is a graphical diagram of percentage of carbon monoxide emission versus the engine speed according to the effects of the carburetion system embodying the invention.

DESCRIPTION AND OPERATION

As shown in FIG. 1, the carburetion system embodying the invention comprises a carburetor **1** including an air intake conduit or tubular casing **2** having an air intake passageway **3** extending coaxially therethrough with a venturi **4** formed in said passageway. In conventional manner, the upstream end of passageway **3** is connected to an air cleaner device (not shown), and the downstream end is connected to an intake manifold (not shown) of an internal combustion engine (not shown). An accelerating throttle valve **5** is arranged in conventional manner in a uniform-diameter portion **6** of the casing **2** downstream of the venturi **4.** An annular chamber **7** is formed in the casing **2** in surrounding relation to the smallest diameter or throat region of the venturi **4** with a connecting passageway **8** leading from said chamber to the exterior of the carburetor **1.** The throat region of venturi **4** is connected to annular chamber **7** via a plurality of angularly spaced passageways **9** extending radially in a common plane passing through the smallest diameter of said thraot and perpendicular to the axis of the venturi. Two other pluralities of similarly formed passageways **10** and **11** also connect the venturi throat region to chamber **7** and are disposed in planes, one above and one below, the plane in which the passageways **9** lie.

A main jet **12** of the carburetor **1** is fixed transversely in the uniform-diameter portion **6** between venturi **4** and throttle valve **5.** This main jet **12** comprises an induction manifold **13** of tubular form extending diametrically through the intake passageway **3** and removably secured at both ends in the tubular casing **2.** Manifold **13** is provided with two sets of openings or nozzles **14** and **15** extending laterally of the plane containing the respective axes of said manifold and of intake passageway **3,** each of said sets comprising respective pairs of such nozzles arranged on opposite sides of said plane and extending obliquely downwards, as viewed in the drawing.

The manifold **13** also acts as a support for the lower end of guide rod **16** extending coaxially through the venturi **4,** the upper end of said rod being secured to a support member or finger **17** extending radially from and supported on the inner wall of an annular connector **18** connecting the upstream end of carburetor **1** to the air cleaner (not shown). A generally bell-shaped throttle or metering element **19** is coaxially slidable on rod **16** and is urged by a calibrated spring **20** fitted on the rod between said element and the manifold **13** toward a normal or idling position resting against the support member **17.**

The bell shape of the metering element **19** is flared in the direction of flow of intake air through the intake passageway 3, as indicated by the arrows at both ends of the carburetor 1, and is of such axial length that, when in its normal or idling position against support member 17 and in which it is shown in the drawing, its maximum diameter is at an axial position or level between the two sets of passageways 9 and 10. When throttle valve 5 is opened to cause air, in well-known manner, to be drawn into the carburetor 1 and through the intake passageway 3 including venturi 4, the flow or dynamic action of such air carries the metering element 19 downwardly to an extent commensurate with the amount the throttle valve is opened, the maximum downward movement being to a maximum speed position against the manifold 13 and corresponding to the maximum rate of engine revolution. The maximum speed position of metering element 19 being shown in broken outline in the drawing.

Progressive, downward axial displacement of metering element 19 past the openings of passageways 10, 9, and 11, respectively, toward its maximum speed position produces a vacuum effect or impulse in each of said passageways which vacuum effect is communicated to annular chamber 7 to produce therein a signal impulse which is a resultant impulse of all the vacuum impulses effected in the several sets of said passageways 10, 9, and 11. Obviously, this resultant impulse is varied not only by the position of the metering element 19, relative to the passageways 9, 10, and 11, but also by the velocity of air flow through the venturi 4, and, therefore, the degree of such impulse may be predetermined by properly selecting the profile and shape of metering element 19, the dimension and number of sais passageways, and the relative positions of said passageways with the venturi 4.

Assuming that the carburetor 1 were provided with the set of passageways 9 only, the impulse effected in chamber 7 would vary not only according to air speed flowing through venturi 4 but would also be affected by the position of metering element 19. Thus, with the type of fule supply system shown and to be more fully described hereinafter, mixture of the fuel supply to the engine, as effected by the impulse produced by only one set of passageways 9, would produce the curve A shown in FIG. 2 which indicates a relatively high content of carbon monoxide in the exhaust gases for lower engine speeds. With the use of the additional sets of passageways 10 and 11, however, the signal impulse produced thereby produces a fuel mixture from which the curve B shown in FIG. 2 is obtained, said curve indicating a considerable less amount of carbon monoxide in the exhaust gases during lower engine speeds. As may be seen in FIG. 1, at lower speeds and loads of the engine, the metering element 19 occupies a range of positions in which a high degree of vacuum would be caused in the passageway 9, if no other passageways were provided, which vacuum alone would produce such an impulse as to effect an excessively enriched fuel mixture drawn by the engine. With the use of the additional sets of passageways 10 and 11, however, the degree of the impulse is reduced thereby to effect a more accureately blended fuel mixture. On the other hand, at higher engine speeds and loads, the metering element 19 occupies a range of positions such that, in the absence of passageways 11, the resulting vacuum impulse would be so weak as to effect an excessively thin blend of fuel mixture.

In order that the fuel supply system functions to provide the most effective fuel mixture, the vacuum impulse communicated to chamber 7 and, therefore, to connecting passageway 8 is related to a reference impulse or signal. This reference impulse is obtained from an L-shaped passageway 21 formed adjacent the periphery of the annular connector 18, one branch of said passageway being formed parallel to an opening into the flow of intake air from the air cleaner (not shown), while the other branch leads to the exterior of said connector.

An idling mixture passageway or jet 22 formed in the wall of uniform-diameter portion 6 extends from the exterior and opens to the interior thereof slightly downstream of the throttle valve 5, which is shown in a closed position. A progression passageway or jet 23 also formed in the wall of casing portion 6 extends from the exterior and opens to the interior thereof slightly upstream of throttle valve 5, when the latter is in its closed position, the interior region of said casing portion between said throttle valve and the manifold 13 being designated as a mixing chamber 24. Finally, a drain passageway 25 is formed between one end of manifold 13 and the exterior of casing portion 6. The purpose of the passageways 22, 23, and 25 will be set forth hereinafter.

The fuel supply apparatus, as shown in FIG. 1, also comprises a fuel tank 26 from which fuel is drawn by a pump 27 and delivered through a pipe 28, in which said pump and a filter 29 are serially interposed, to a fluidic regulator or amplifier 30. Since the fluidic regulator 30 may be of conventioanl type, a detailed description thereof is not deemed necessary and therefore is shown diagrammaticaly.

The fluidic regulator 30 is provided with two control channels or input ports 31, 32 acting in opposition on a fuel stream flowing through a supply channel or port 33 extending through said regulator transversely to said control channels, the upper end of said supply channel, as viewed in the drawing, being connected to the portion of pipe 28 leading from filter 29. In well-known manner of operation of fluidic amplifiers when the vacuum in port 32 is increased relative to that of port 31, part of the fuel flow in supply channel 33 is deflected into a branch channel or delivery port 34 which feeds manifold 13 through a pipe 35 interconnected therebetween. The remaining portion of the fuel flows back to tank 26 via a delivery channel or port 36 (continuing from supply channel 33) and a pipe 37 connected to the lower end of delivery channel 36, as viewed in the drawing.

Control channel 32 is connected via a pipe 38 to connecting passageway 8, so that the resultant vacuum impulse of the respective impulses transmitted from the sets of passageways 9, 10, and 11 to chamber 7 is thereby communicated to and effects the pressure in said control channel. Control channel 31 is connected via a pipe 39 to the L-shaped passageway 21 in the connector 18 of the carburetor 1 and, therefore is affected by the reference impulse therefrom. A three-way valve 40 is interposed in pipe 38 so that control channel 31 may be connected to reference passageway 21 either directly via pipe 39 only, or indirectly via a branch pipe 41 arranged in parallel relation to pipe 39 and in which branch pipe a calibrated choke 42 is interposed.

Pipe 37 leading from delivery channel 33 of the fluidic regulator 30 has a pipe 43 leading therefrom and commonly connecting to three branch pipes **44, 45,** and **46** connected with drain passageway **25,** progression passageway **23** and idling passageway **22,** respectively. A calibrated choke **47** is interposed in pipe **43,** and an adjustable choke **48** is interposed in branch pipe **46.** The branch pipe **44** allows fuel droplets forming at the opening of manifold **13** during engine idling to drain into branch pipe **46** leading to idling passageway **22.** Air for emulsifying or atomizing the fuel supplied to branch pipes **45** and **46** is provided via an air pipe **49** connecting said branch pipes and to pipe **39** leading from the reference passageway **21.** A branch conduit **50** also connects air pipe **49** with pipe **35** from branch channel **34** of the fluidic regulator **30** for atomizing fuel supply directed to manifold **13** through pupe **35.**

In operation, the control impulse in channel **32** of the regulator **30,** to some degree, is alsways negative, that is, a partial vacuum with respect to reference impulse in channel **31.** As was above noted, the control impulse in channel **32** is accurately established for various engine speeds by automatic cooperation of the metering element **19** with the passageways **9, 10,** and **11.** The inertia mass of the metering element **19** is precalculated so as to respond with a desired delay to sudden opening of the throttle valve **5.** Thus, with the metering element **19** in its idling position, if the throttle valve **5** is suddenly opened, the inertia of said metering element tends to delay it in its said idling position thereby causing a momentary delay in adjustment of the control impulse delivered to channel **32** such that when such impulse is effected, that is, when said element moves toward its maximum speed position above defined, the result is a sharper, more pronounced impulse in channel **32** which effects delivery of a greater quantity of fuel to manifold **13** for prompt response by the engine.

During idling of the engine, the throttle valve **5** is in its closed position, as shown in FIG. **1,** and, therefore, in the absence of air flow in venturi **4,** the respective control impulses in the control channels **31** and **32** of the regulator **30** are substantially balanced. Moreover, since the progression passageway **23** also remains inactive due to lack of air flow through the carburetor intake passageway **3,** only the idling passageway **22** supplies the engine with fuel (from pipe **43**) and air (from pipe **49**) in a quantity measured by the fixed choke **47** and the adjustable choke **48.** Under such idling conditions, however, it is practically impossible to avoid a very small flow of fuel to channel **34** of the regulator **30,** hence toward manifold **13** via pipe **35** which could cause idling instability. Such idling instability is avoided by draining off such fuel via drain passageway **25** and pipe **44** into pipe **49** thence into pipe **46** at a point ahead of adjustable choke **48.**

With slight or partial opening of throttle valve **5** to an initial position such as indicated by the broken outline in FIG. **1,** progression passageway **23** is activated by the resulting air flow therepast, while suction of fuel and air mixture from the idling passageway **22** is substantially reduced, although air flow through venturi **4,** at this point is not powerful enough yet to provide adequate supply to manifold **13.** It should be obvious, however, that with throttle valve **5** in its initial position, a substantial quantity of fuel and air mixture is drawn from progression passageway **23** and is sufficient for effecting a smooth even progression of engine acceleration.

With the engine running at high speeds, the metering element **19,** as previously noted, occupies its maximum speed position indicated by the broken outline in the drawing, in which position, the central portion of the manifold **13** is screened off from air flow through intake passageway **3.** For this reason and according to the invention, the two sets of nozzles **14** and **15** are located in manifold **13** so as to be clear of the central portion of said manifold screened off by metering element **19** and thereby exposed to the flow action of air intake at all positions of said metering element. It should also be obvious that the manifold **13** is disposed transversely to the axis of intake passageway **3** to provide the most effective response to air flow action even with slight openings of throttle valve **5.**

Although the metering element **19** is shown as being substantially bell shaped and the guide rod **16** as circular in cross-section, said metering element need not be limited to such shape. For instance, the metering element could be of elliptical or polygonal cross-section with a prismatic guide on the support rod which, if desired, might extend helically with a predetermined pitch equivalent to one-fourth or one-half of the amount of axial movement or stroke length of said metering element. In this case, with passageways **9, 10,** and **11** arranged diametrically in a single axial plane, the cross-section of the metering element and its angular position (variable with its stroke length) on the guide rod would be the factors determining the control impulses set up in said passageways.

It should also be understood that the actual arrangement of the various pipes and channels need not necessarily be designed as shown in the drawing. For instance, most of such pipes and channels could be formed as passageways within the carburetor casing **2** or with the casing of fluid regulator **30** which could be attached directly to said carburetor casing.

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

1. A carburetion system for internal combustion engines, comprising:

a. an air intake conduit having an upstream end and a downstream end;

b. a throttle valve in said intake conduit adjacent the downstream end, said throttle valve having a closed position, in which air flow through the intake conduit is cut off, and being operable to an open position of varying degrees for increasing the amount of air flow proportionally with the degree to which the throttle valve is opened;

c. a fuel manifold having at least one nozzle thereon opening to said air intake conduit upstream of said throttle valve;

d. a fluidic regulator having a supply port for receiving fuel under pressure, a pair of delivery ports, and a pair of control pressure input ports;

e. first passage means communicating one of said delivery ports to said fuel manifold;

f. pressure transmitting means for providing a pressure differential across said control pressure input ports for effecting delivery of fuel to said one delivery port in accordance with the degree of said pressure differential,

g. said pressure transmitting means including second passage means communicating one of said control pressure input ports to said air intake conduit adjacent said upstream end thereof for transmitting a first pressure impulse to said one input port,

h. said pressure transmitting means further including third passage means with one end opening to said air intake conduit intermediate said upstream end and said throttle valve for communicating said air intake conduit to the other of said input ports; and

i. metering means coaxially operably disposed and biased to a normal position in said intake conduit relative to said one end of said third passage means and forming a constriction of air flow space therebetween to effect a second pressure impulse of a certain degree relative to said first impulse and transmitted via said third passage means to the other of said input ports for establishing a minimum pressure differential across the input ports,

j. said metering means being yieldingly operable out of said normal position in response to air flow through the intake conduit and to an extent commensurate with the degree to which the throttle valve is opened for reducing said constriction and varying the degree of said second impulse accordingly.

2. A carburetion system, as set forth in claim **1**, wherein said air intake conduit is provided with a venturi intermediate said upstream and downstream ends, and said one end of said third passage means opens into said venturi at the samllest diameter of the venturi throat.

3. A carburetion system, as set forth in claim **2**, wherein said third passage means comprises a plurality of angularly spaced passageways extending radially in a common plane passing through said smallest diameter of the venturi and perpendicular to the axis thereof, each of said passageways having one end opening to the interior of said air intake conduit with the other end thereof opening to a common annular chamber formed in the air intake conduit and communicated to the other of said input ports.

4. A carburetion system, as set forth in claim **3**, wherein said third passage means further comprises second and third pluralities of angularly spaced passageways formed similarly to said first-mentioned plurality and disposed in respective common planes situated upstream and downstream of and parallel to said first-mentioned common plane, said passageways of said second and third pluralities also each having one end open to the throat region of said venturi with the other ends thereof opening to said annular chamber.

5. A carburetion system, as set forth in claim **4**, wherein said metering means comprises:

a. a guide rod extending coaxially through said venturi;

b. a bell-shaped metering element slidably carried on said guide rod and flared in the direction of air flow through the intake conduit; and

c. a spring for urging said metering element toward said normal position in which the axial position of the largest diameter portion of said metering element generally coincides with the throat of the venturi.

6. A carburetion system, as set forth in claim **5**, wherein said fuel manifold comprises a tubular element extending diametrically through the air intake conduit downstream of the venturi and upstream of said throttle valve.

7. A carburetion system, as set forth in claim **1**, further characterized by:

a. an idling jet opening to said intake conduit downstream of the throttle valve and connected to said second passage means and, via choke means, to said one of said delivery ports, said idling jet being effective in the closed position of said throttle valve for supplying fuel mixture to the engine at a restricted rate; and

b. a progression jet opening to said intake conduit upstream of the throttle valve and downstream of the fuel manifold and connected to said second passage means and to the other of said delivery ports, said progression jet being effective, immediately upon opening of the throttle valve, for providing an initial supply of fuel mixture to the engine pending supply via the fuel manifold.

8. A carburetion system, as set forth in claim **7**, further characterized by drain means formed adjacent one end of said fuel manifold and connected to said idling jet for draining fuel condensate from said manifold during idling operation.

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