

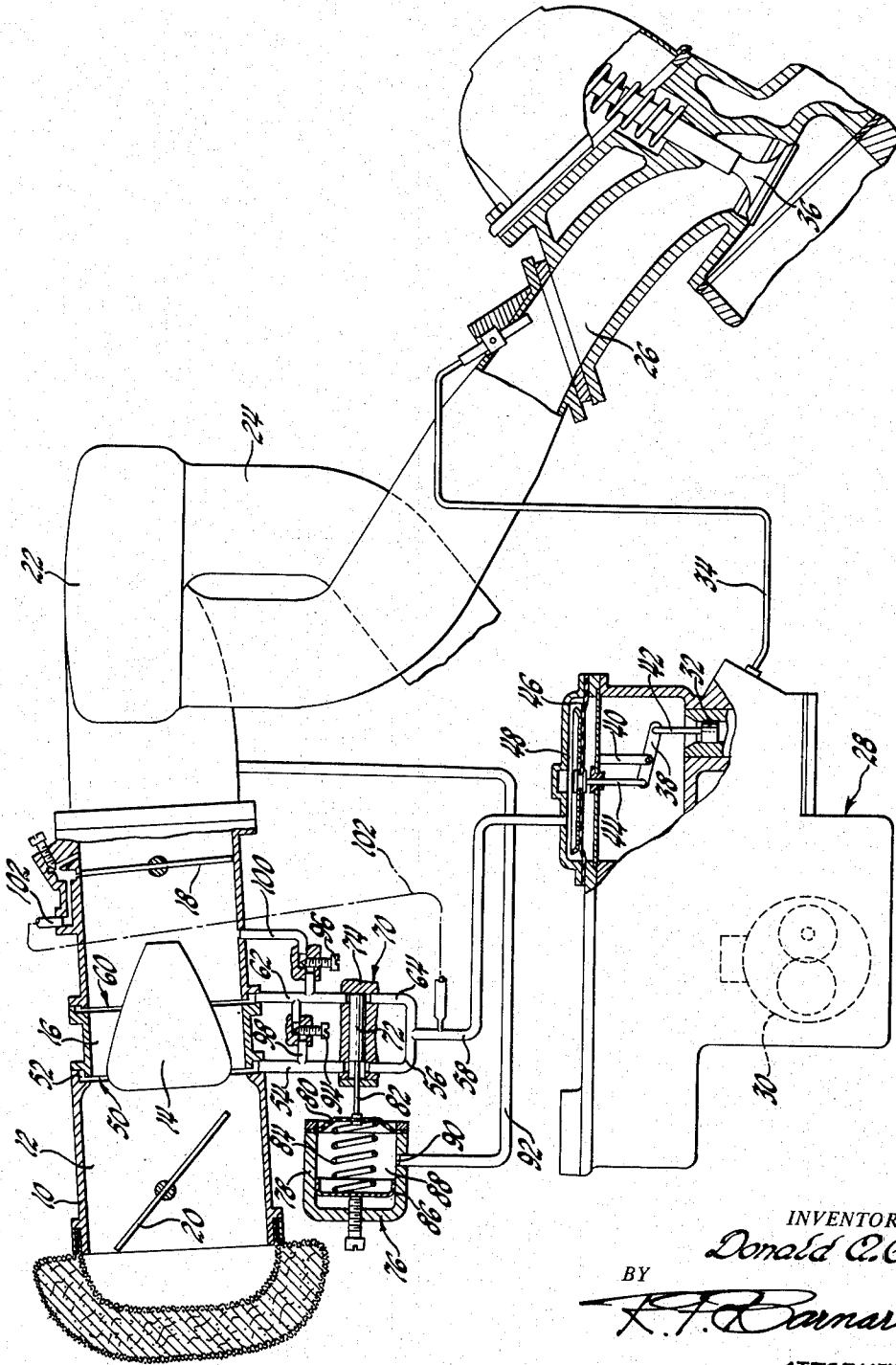
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FUEL INJECTION METERING SYSTEM

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FUEL INJECTION METERING SYSTEM

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The present device relates to a fuel metering device for a fuel injection system. More specifically the present device is an improvement in a fuel metering device of the type shown in Serial No. 608,853 Dolza, filed September 10, 1956.

In a continuous flow fuel injection system of the type shown in the aforementioned Dolza case it is normally necessary to provide two fuel-air ratio ranges, one for maximum power and the other for best economy. In the basic system the fuel-air ratio ranges are achieved by utilizing a metering valve control linkage which includes an adjustable fulcrum. The adjustment of the fulcrum is achieved through changes in engine load and alters the mechanical advantage of the linkage to vary enrichment. The present metering control system represents a device which eliminates the adjustable fulcrum and its attendant disadvantages. In this way the metering mechanism is simplified and the general functioning of the system improved by eliminating the inertia effects which have resulted in a hysteresis in fuel control in the earlier mechanism.

In the present device a fixed fulcrum is used in the diaphragm linkage system which controls the fuel metering valve and the various fuel-air ratio ranges corresponding to maximum power or best economy operation are realized through the use of a plurality of axially spaced piezometer rings within the air venturi.

In providing a plurality of vacuum signal measuring devices or piezometers, it is possible to position one such device to utilize a maximum signal for maximum power and another at a position yielding a signal compatible with best economy operation. With the present system means is provided for selecting or blending such signals to provide the requisite fuel flow in accordance with engine demand. In this instance the various flow signals are modified by a blending valve which responds to changes in engine load as manifested through manifold vacuum.

In the present device it is possible, under high power demand conditions, to deliver a maximum metering signal to the control diaphragm while under low load conditions to deliver a lower metering signal which conditions the control system for a more economical use of fuel.

It is a further object and advantage of the subject system that an infinite number of fuel-air ratios are obtainable between the maximum power and maximum economy ratio settings facilitating a smooth transition from one condition to another.

The details of the present invention as well as other objects and advantages are set forth in the description which follows.

The drawing represents a fuel injection system embodying the subject invention.

The fuel injection system with which the present invention has been illustrated functions in the same manner as the aforementioned Dolza system, except as will be specifically pointed out in the description which follows. An air intake casing is shown at 10 and includes an induction passage 12 formed therein. A tapered plug 14 is disposed in

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the intake passage 12 and forms an annular venturi 16 therewith. A throttle valve 18 is disposed posteriorly of the venturi 16. If it is so desired, a signal modifier valve 20 may be disposed anteriorly of the venturi 16 in order to provide proper cold starting and running operation of such system. The signal modifier valve is shown and described in copending application Serial No. 658,091, Dolza and Kolb, filed May 9, 1957.

The induction casing 10 communicates with an air manifold or plenum chamber 22 from which a plurality of passages 24 extend to communicate with the individual cylinder intake passages 26 of the engine.

A source of fuel under pressure is shown generally at 28 and includes an engine speed responsive pump 30 adapted to deliver fuel to a metering valve 32, the latter which is adapted to control the quantity of fuel flowing to conduits 34 individually supplying fuel to each cylinder supply passage 26 anterior of a cylinder intake valve 36.

The metering valve 32 is in this instance controlled by a linkage mechanism including a lever 38 mounted intermediate its ends on a fixed fulcrum 40. Rods 42 and 44 respectively connect the ends of lever 38 to the metering valve 32 and to a vacuum actuated diaphragm 46. The movement of the diaphragm controls the quantity of fuel metered by the valve 32 with such quantity increasing as the vacuum force in diaphragm chamber 48 increases.

To provide a maximum vacuum signal for supplying requisite fuel for maximum power operation a piezometer ring 50 is provided at the most restricted portion or throat of the venturi 16. The piezometer ring 50 includes an annular chamber 52 formed in the intake casing 10 and open at its radially inner end to communicate with the venturi 16. The vacuum in chamber 52 varies as a square of the mass of air flowing through the venturi and under all conditions represents the maximum single signal generated within the venturi for a given rate of flow. The vacuum in chamber 52 is communicated to the diaphragm chamber 48 through conduits 54, 56 and 58.

To achieve a fuel flow consistent with best economy operation, the present device provides means for reducing the metering vacuum control signal to a level compatible with economical fuel consumption. Accordingly, a second piezometer ring 60 is formed in the intake casing 10 and similarly communicates with the venturi 16 but at a point posterior or downstream from the first ring 50. It is apparent that the vacuum force in ring 60 will always be less than that in ring 50 due to the decreased velocity of the air flowing therepast. The vacuum force in ring 60 is adapted to be transmitted to the diaphragm control chamber 48 through conduits 62, 64 and the common conduit 58. Thus piezometer rings 50 and 60 respectively establish vacuum ranges compatible with maximum power or best economy.

It is necessary, however, to provide further means whereby a selection of these metering forces is made in accordance with the needs of the engine. Accordingly, a valve device is provided generally at 70 and includes a valve member 72 slidably disposed in a casing 74 and adapted to cooperate with vacuum conduits 54, 56, 62 and 64 to control the transmission of vacuum forces there-through. With the valve member 72 in the position shown, conduit 64 is blocked preventing communication between the second piezometer ring 60 and the diaphragm control chamber 48. At the same time conduit 56 is fully open to conduit 54 communicating the maximum vacuum metering force in the first piezometer ring 50 with chamber 48.

The slidable valve member 72 is adapted to be controlled by a manifold vacuum responsive mechanism 76 which includes a casing 78 having a diaphragm 80 mounted therein and connected to the valve member

through a rod 82. A spring 84 is seated upon an adjustable seat 86 and is adapted to bias the diaphragm 80 and metering valve 72 to the position shown in the drawing. The chamber 88 defined by casing 78 and diaphragm 80 communicates through a port 90 and a conduit 92 with the induction passage 12 posteriorly of throttle 18. Thus manifold depression is continuously communicated to chamber 88 and is adapted to affect the positioning of valve 72 in accordance with the magnitude of such depression. During normal engine operation the manifold vacuum or depression in chamber 88 overcomes spring 84 to move the diaphragm 80 to the left causing valve member 72 to block the maximum vacuum signal conduit 56 and communicate conduit 62 with the diaphragm chamber 48 for best economy operation. Under a condition requiring maximum fuel flow, which would normally be attended by a sudden depression of the accelerator pedal, the drop in manifold vacuum would permit spring 84 to shift valve 72 to the position shown in the drawing. As a consequence, the maximum metering control force is transmitted to the diaphragm chamber 48 to increase the fuel flow through the metering valve 32.

It is apparent that between the positions transmitting the maximum metering signal or the economy metering signal, the valve 72 may actually transmit a vacuum force to the diaphragm control chamber 48 which is a blend of the two basic forces. In other words, valve 72 moves through positions in which vacuum is being supplied through both the conduits 54 and 62. The advantage of thus blending the metering control forces is in the resultant smoothness of transition from one condition to another rather than making an abrupt change between the power and economy fuel-air ratio ranges.

In order to permit adjustment of the basic metering signals in conduits 54 and 62 adjustable bleed valves 94 and 96 are respectively provided. Bleed valve 94 is disposed in a conduit 98 which interconnects conduits 54 and 62. The maximum metering signal may be varied by bleeding the higher pressure from conduit 62 into conduit 54. Similarly, a conduit 100 communicates conduit 62 with the intake passage 12 intermediate the venturi 16 and the throttle valve 18. The bleed of higher pressure air from the induction passage 12 to conduit 62 is controlled by adjustable valve 96.

A conduit 102 communicates with the common conduit 58 and is adapted to deliver a vacuum force thereto during idling conditions as described in copending application Serial No. 608,797 Olson, filed September 10, 1956.

Another important advantage of the present dual signal system occurs during acceleration. The rapid opening of throttle 18 during acceleration causes a momentary in-rush of air through the induction passage 12 in an effort to fill the intake manifold. This in-rush of air produces a spike or momentary peak in the metering control vacuum signal which facilitates the increased flow of fuel required during acceleration. In addition, however, an acceleration transient will reduce manifold vacuum sufficiently to cause a shift of the valve 72 to some intermediate position to combine the vacuum forces available in both conduits 54 and 62 which coupled with the spike signal will insure adequate fuel enrichment for rapid acceleration.

The subject invention has been illustrated in a diagrammatic form and it is apparent that various modifications thereof might be made within the intended scope of the invention as set forth in the hereinafter appended claims.

I claim:

1. A fuel injection system for an internal combustion engine comprising an air intake passage, a venturi formed in said passage, a throttle valve formed in said passage anteriorly of said venturi, individual intake passages communicating each cylinder of said engine with said air induction passage, a source of fuel under pressure, con-

duit means for communicating said fuel source with the individual intake passages, a metering valve disposed in said conduit means for regulating the quantity of fuel supplied to the individual cylinders of said engine, vacuum responsive means connected to said metering valve for controlling the actuation thereof, conduit means communicating said vacuum responsive means with the induction passage at a plurality of axially spaced positions within said venturi, a different vacuum force existing in said conduit means at each of said positions, and engine load responsive means for controlling the vacuum force conveyed by said conduit means to said vacuum responsive means.

2. A fuel injection system for an internal combustion engine comprising an air intake passage, a venturi disposed in said induction passage, a throttle valve mounted in said induction passage anteriorly of said venturi, intake passages communicating each individual cylinder of the engine with said induction passage, a source of fuel under pressure, conduit means for conveying said fuel under pressure to said intake passages, a metering valve in said conduit means for controlling the quantity of fuel supplied to the individual engine cylinders, diaphragm means connected to said metering valve for controlling the actuation thereof, a first annular passage formed in said intake passage and communicating with said venturi, first passage means connecting said first annular chamber and said diaphragm, a second annular chamber formed in said induction passage and communicating with said venturi at a point axially spaced from said first annular chamber, second passage means connecting said second annular chamber to said diaphragm means, a vacuum force being created in each annular chamber proportional to the mass of air through associated portion of the venturi, valve means for controlling the vacuum force transmitted to said diaphragm means from said first and second annular chambers, manifold vacuum responsive means for controlling said venturi vacuum valve, and means normally biasing said venturi vacuum valve to a position blocking flow through one of said chamber passage means, said manifold vacuum control means being adapted to move said valve to a position blocking flow through the other of said chamber passage means.

3. A fuel injection system for an internal combustion engine comprising an air intake passage, a venturi formed in said passage, a throttle valve formed in said passage anteriorly of said venturi, individual intake passages communicating each cylinder of said engine with said air induction passage, a source of fuel under pressure, conduit means for communicating said fuel source with the individual intake passages, a metering valve disposed in said conduit means for regulating the quantity of fuel supplied to the individual cylinders of said engine, vacuum responsive means connected to said metering valve for controlling the actuation thereof, conduit means communicating said vacuum responsive means with the induction passage at a plurality of axially spaced positions within said venturi, a different vacuum force existing in said conduit means at each of said positions, a valve member associated with said conduit means for selecting the vacuum force conveyed to said vacuum responsive means, means normally biasing said valve member to transmit vacuum from only one of said positions, and engine load responsive means for shifting said valve member to transmit vacuum from another of said positions.

4. A fuel injection system as set forth in claim 3 in which said engine load responsive means comprises a casing, a diaphragm mounted in the casing and operatively connected to said valve member, and a conduit connecting the casing with the induction passage posteriorly of said throttle valve.

5. A fuel injection system as defined in claim 1 in

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which one of said plurality of spaced positions includes the point of maximum air flow velocity.

6. A fuel injection system as defined in claim 2 in which said first annular chamber communicates with said venturi at the point of maximum air flow velocity and in which said biasing means normally biases said valve to communicate the first annular chamber with the diaphragm means.

7. A fuel injection system for an internal combustion engine comprising an air intake passage, a venturi disposed in said induction passage, a throttle valve mounted in said induction passage anteriorly of said venturi, intake passages communicating each individual cylinder of the engine with said induction passage, a source of fuel under pressure, conduit means for conveying said fuel under pressure to said intake passages, a metering valve in said conduit means for controlling the quantity of fuel supplied to the individual engine cylinders, diaphragm means connected to said metering valve for controlling the actuation thereof, a first annular passage formed in said intake passage and communicating with said venturi, first passage means connecting said first annular chamber and said diaphragm, a second annular chamber formed in said induction passage and communicating with said venturi at a point axially spaced from said first annular chamber, second passage means con-

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necting said second annular chamber to said diaphragm means, a vacuum force being created in each annular chamber proportional to the mass of air through associated portion of the venturi, a first bleed passage interconnecting said first passage means and said second passage means intermediate said valve means and said venturi, an adjustable valve in said first bleed passage, a second bleed passage communicating said second passage means intermediate said valve means and said venturi with said induction passage posteriorly of said venturi, and an adjustable valve member in said second bleed passage, valve means for controlling the vacuum force transmitted to said diaphragm means from said first and second annular chambers, manifold vacuum responsive means for controlling said venturi vacuum valve, and means normally biasing said venturi vacuum valve to a position blocking flow through one of said chamber passage means, said manifold vacuum control means being adapted to move said valve to a position blocking flow through the other of said chamber passage means.

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