Sept. 15, 1959 G. B. KLABER 2,904,264

FUEL INJECTION NOZZLE

Filed April 29, 1957

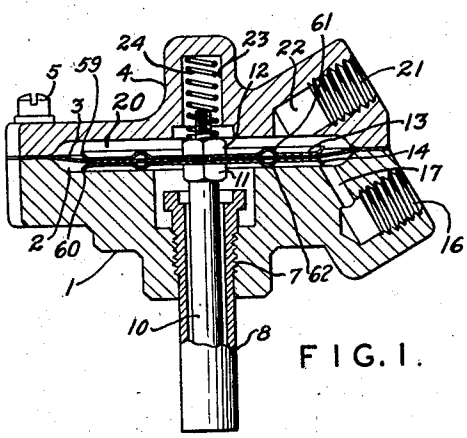


FIG. 1.

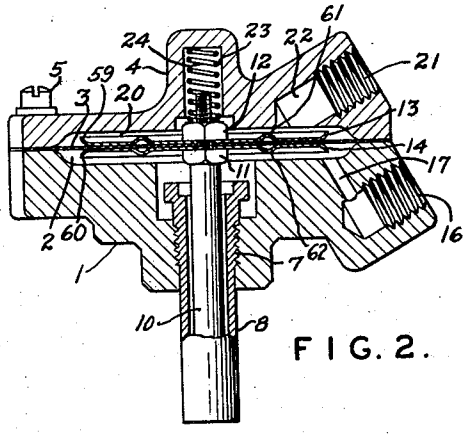


FIG. 2.

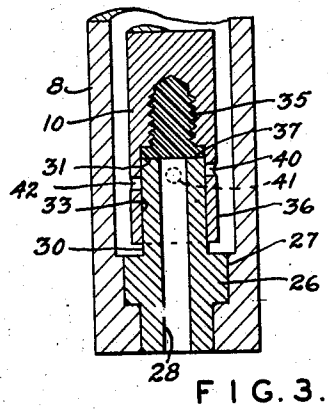


FIG. 3.

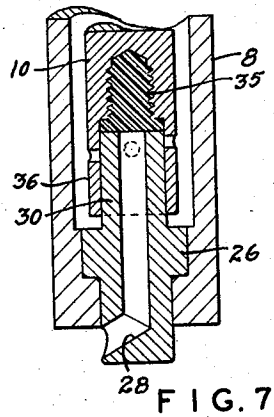


FIG. 7.

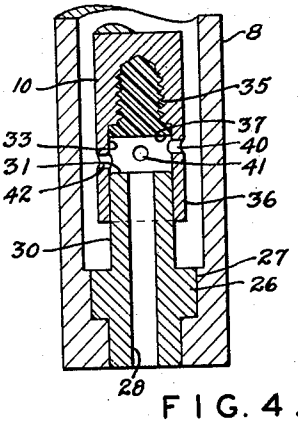


FIG. 4.

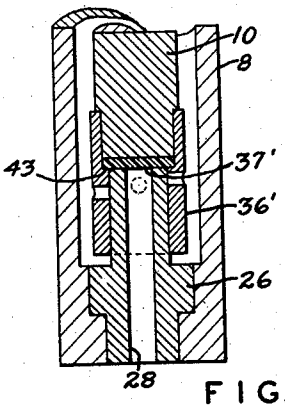


FIG. 5.

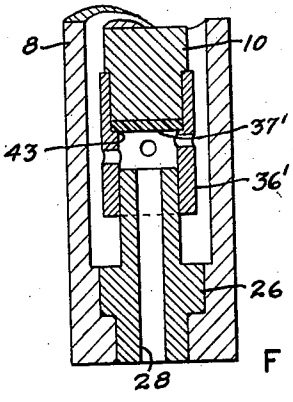


FIG. 6.

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FUEL INJECTION NOZZLE

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12 Claims. (Cl. 239—533)

This invention relates to fuel nozzles, and more specifically to the type of nozzle for discharging fuel into the air induction system or cylinders of an internal combustion engine.

The primary object of this invention is a fuel nozzle which will properly control the discharge of fuel and at the same time perform the discharge pressure regulating function required when used with a system for flow dividing such as, for example, that shown in a prior patent to James Fred Armstrong No. 2,785,669 of March 19, 1957, for "Injection Carburetion."

In order to attain this object, the construction of the nozzle must, obviously, permit free valve travel in response to slight pressure differentials, and the valve parts must be guided into and out of engagement to provide the necessary uniform throttling of the fuel flow.

It is also desirable in nozzles of this type that the pressure regulation function be performed in a specific manner. At small rates of flow, a comparatively large valve travel is desirable, so that the flow will be continuous, rather than intermittent, in spite of small pressure fluctuations. On the other hand, above minimum rates of flow it is desirable that comparatively small amounts of valve travel produce rapid changes in flow, so that the regulator pressure response as a whole will be rapid and suit the fuel requirements of the engine during acceleration and deceleration.

It has been discovered that the regulator construction disclosed herein has the above advantages in operation, as well as additional advantages, all of which will appear in the following detailed description of the structure taken with the accompanying drawings, in which:

Fig. 1 is a vertical elevational view, partly in section, illustrating the position of the parts when fuel discharge is cut off.

Fig. 2 is a similar view illustrating the position of the parts during discharge of fuel from the nozzle.

Fig. 3 is a vertical section showing the valve parts of the regulator, on an enlarged scale, when the fuel discharge is cut off as in Fig. 1.

Fig. 4 is a similar view of the nozzle valve illustrating the position of the parts with the valve wide open during fuel discharge as in Fig. 2.

Fig. 5 is a similar view to Fig. 3, illustrating one modification.

Fig. 6 is a similar view to Fig. 5, illustrating the same modification with the valve wide open.

Fig. 7 is a vertical section showing a modification of the nozzle on an enlarged scale.

Nozzle structure

Referring now to the drawings, and especially Figs. 1 and 2 thereof, the nozzle diaphragm housing 1 contains a chamber 2 which is closed by a movable wall formed by diaphragm 3 secured between the housing 1 and a cap 4. A plurality of screws 5 attach the cap to the housing. A central, threaded aperture 7 in the housing communicates with the chamber 2, and threadedly receives a

nozzle tube 8. Within the nozzle tube is a valve stem 10 which is secured centrally of the diaphragm 3 by suitable means such as a pair of nuts 11 and 12 which clamp a pair of backing plates 13 and 14 against opposite sides of the diaphragm 3.

The expansible chamber 2 is supplied with fuel through a threaded connection 16 and connecting passage 17. The valve stem 10 is guided at its upper end by the diaphragm 3, but, of course, if desired, separate guides for locating the stem 10 may be provided. The stem 10 in any of these modifications may include a resilient or universal coupling as disclosed in the abovementioned prior application of James Fred Armstrong.

The cap 4 is formed with a chamber 20, which is supplied with fluid at a predetermined regulating pressure through the threaded connection 21 and passage 22. A centrally located socket 23 in the cap 24 receives and forms a seat for the light spring 24 compressed between the cap and the valve stem 10.

The backing plates 13 and 14 may be formed with suitable ribs 59, 60, 61 and 62 for limiting the movement of the diaphragm within the expansible chambers 2 and 20, all in a manner described and illustrated in the aforementioned co-pending application of James Fred Armstrong.

Referring now to Figs. 3 and 4, wherein the valve structure for the pressure regulator in Figs. 1 and 2 is shown on an enlarged scale, the tube 8 is open at its lower end and receives therein the nozzle 26. The tube 8 is suitably socketed at 27, so that the nozzle may be forced into assembled relation with the tube by a press fit, and the nozzle 26 is drilled at 28 to form a discharge passage. As shown, the passage 28 is coaxial, but it is possible, in the design of the nozzle, to drill this passage in any direction from its lower end so as to distribute the discharging fuel in any or all directions, as desired. For example, the nozzle 26 may have a protruding part projecting below the stem 8 which may be drilled radially or diagonally for this same purpose, as in Fig. 7.

At the upper end of the nozzle 26 is a cylindrical guide portion 30 which terminates at 31 to form a flat, annular seat which will act as one of the seating surfaces of the valve part. Within the valve stem is a coaxially arranged, threaded socket 35 forming an extension of a counterbore 33 in the end of the valve stem 10. This counterbore 33 forms a cylindrical extension or sleeve 36 which is dimensioned to closely fit and be guided by the portion 30 of the nozzle 26. The socket 35 contains suitable valve seat material molded in place. This material is preferably plastic, or a combination of plastic and fiber, and forms the other seating surface of the valve for the regulator. After the seat is molded in place, it may be milled flat by a suitable tool inserted through the counterbore 33. The manner described of forming the valve parts provides a valve seat of large cross-sectional area to minimize the mechanical pressure per unit of area between the seating surfaces. Likewise, it will reduce the per unit of area of fluid pressure on the seat, which necessarily increases the life of the valve-seating surfaces.

The manner of securing the insert avoids radial distortion due to the inter-engagement of the seating faces of the valve, and also prevents loosening of the insert due to shrinkage because of high mechanical unit pressures or heat cycling. If desired, the valve seating surfaces 31 and 37 may be contoured in any suitable manner—concave or convex—so that the annular opening formed as the valve lifts slightly has an effective throttling action on the flow of fuel.

The cylindrical wall 36 may be provided with a slot or a plurality of holes or orifices as shown. These orifices 40, 41 and 42 are preferably arranged in the manner

illustrated, so that they will open sequentially. In the modification shown, the hole **40** is .031 of an inch in diameter, and is located with its edge spaced about .015 of an inch from the seating surface **37**. Hole **41** is .036 of an inch and is radially spaced from hole **40**, but overlaps the first hole **40** by .005 of an inch. The hole **42** is .036 of an inch, is radially spaced from hole **41**, and located to overlap the hole **41** by about .020 of an inch, so that the entire stroke from full-open to full-closed amounts to approximately .093 of an inch movement of the surface **37** with respect to the surface **31**.

Operation of nozzle

With this construction, which is preferred, the pressure regulator will have comparatively fast opening with comparatively short stroke, and the throttling of the fuel flow will be performed by openings varying as increasing segments of a circular hole or notch, rather than by varying the annulus of a circle as in a tapered valve and seat of conventional construction. It will be obvious that different engines require different nozzle characteristics which can be obtained by changing orifice size, or location, or even shape.

The fit between the sleeve **36** and the guide **30** is necessary of relatively close tolerance, so that, when the valve seating surfaces move only slightly from their closed position, there will be an initial throttling effect between the cylindrical wall **36** and the guide **30** over a distance of approximately .015 of an inch, which represents the orifice opening between the edge of the hole **40** and the surface **37** of the valve seat. As the valve progressively moves open, this distance becomes shorter, and the throttling of the flow progressively less as the hole **40** is gradually opened. At low rates of flow, this throttling effect is distinctly advantageous because of the gradual rate of change of throttling by comparatively greater movement of the diaphragm to produce the small change in flow from the nozzle **28**. On the other hand, the entire stroke from full-closed to full-open is very short, preferably about .093 of an inch, so that the throttling progressively decreases at the greater rates of flow, minimizing valve travel wear and providing rapid response.

Therefore, in the low rates of flow wherein small movements of the valve produce rapid pressure changes, this structure provides for a thottling action especially effective for small flow because it provides two distinct points of pressure reduction, and so double throttling. The edge of the hole **40** operates as a variable orifice means and produces one pressure drop, and the flow between the seating surfaces **37** and **31** provides a second pressure drop, so that the discharge is regulated to minimize the velocity of flow across the seating surfaces and thereby benefit their operation in resistance to erosion from the fluid.

On the other hand, in the off-idle range of engine operation the rate of fuel flow increases and the valve of the regulator opens at least far enough to expose hole **40**. The throttling action is then performed by the open area of this hole, or some or all of the others, so that erosion of the valve seat **31–37** is eliminated by the throttling effect of the holes acting as a variable orifice means.

Modification

In the modification shown in Figs. 5 and 6, the seat **37'** is prefabricated and then retained in place on the end of the valve stem **10** by the guide sleeve **36'**. In this form the guide sleeve **36'** is not integral with the stem **10**, but is formed separately with an internal seat **43**, which is smaller in diameter than the end of the stem **10**, upon which the sleeve **36'** is secured in a suitable manner. The lip **43** then bears against the lower surface of the seat **37'**, retaining the same in position within the socket formed between the sleeve and the stem **10**. For the purposes of illustration, the guide sleeve **36'** has a force fit to retain it on the end of the stem **10**.

Operation of modification

The modified form disclosed in Figs. 5 and 6 operates in the same manner and has the same inherent advantages as does the modification shown in Figs. 3 and 4, and a further discussion here would seem to serve no useful purpose.

A structure has been described which will fulfill all of the objects of the invention as set forth above, but it is contemplated that other modifications will occur to those skilled in the art, which modifications come within the scope of the appended claims.

I claim:

1. A pressure regulating type of fuel nozzle for an internal combustion engine fuel charging system of the pressure type comprising a housing, a movable wall dividing said housing into opposed expansible chambers in said housing separated by said movable wall, fluid pressure connections for each of said chambers, and a valve operated by said movable wall including a sleeve, a valve seat in said sleeve, a tubular nozzle enclosing said valve and secured to said housing and having a guide located internally thereof for slidable contact within said sleeve, a seat for said valve on said guide, and means for throttling the flow of fluid located in said sleeve upstream of said valve.

2. A pressure regulating type of fuel nozzle for an internal combustion engine fuel charging system of the pressure type comprising a housing, a movable wall dividing said housing into opposed expansible chambers in said housing separated by said movable wall, separate fluid pressure connections opening into each of said chambers, and a valve for said regulator including a sleeve operated by said movable wall, a valve seat internally of said sleeve, a tubular discharge nozzle enclosing said sleeve and extending from said housing, said nozzle having a guide internally of said sleeve, a seat for said valve on said guide, and a means for throttling the flow of fluid located in said sleeve upstream of said valve and operated by movements of said diaphragm.

3. A pressure regulating type of fuel nozzle for an internal combustion engine fuel charging system of the pressure type comprising a housing, a movable wall dividing said housing into opposed expansible chambers in said housing separated by said movable wall, separate fluid pressure connections opening into each of said chambers, and a valve operated by said movable wall including a sleeve moved by said movable wall, a valve seat in said sleeve, a tubular nozzle enclosing said sleeve and extending from said housing, said nozzle having a cylindrical guide in said sleeve, a seat for said valve on said guide, and means for progressively throttling the flow located in said valve upstream of said valve seat and operated by movements of said movable wall.

4. A pressure regulating type of fuel nozzle for an internal combustion engine fuel charging system of the pressure type comprising a housing, a movable wall dividing said housing into opposed expansible chambers in said housing separated by said movable wall, fluid pressure connections for each of said chambers, and a valve operated by said movable wall including a sleeve moved by said movable wall, a valve seat at one end of said sleeve, a tubular nozzle enclosing said sleeve and extending from a chamber in said housing, said nozzle having a cylindrical guide in said sleeve, a seat for said valve at one end of said guide, and means in said valve for varying the flow capacity of said nozzle upstream of said valve seating surfaces.

5. A pressure regulating type of fuel nozzle for an internal combustion engine fuel charging system of the pressure type comprising a housing, a movable wall dividing said housing into opposed expansible chambers in said housing separated by said movable wall, fluid pressure connections for one of said chambers, and a valve operated by said movable wall including a sleeve movable with said movable wall, a valve seat in said sleeve extend-

ing diametrically adjacent one end thereof, a tubular nozzle enclosing said sleeve and extending from said one chamber in said housing, said nozzle having a cylindrical guide for said sleeve, an annular seat for said valve on one end of said guide, and means for varying the flow capacity of said nozzle located between said sleeve and said guide.

6. A pressure regulating type of fuel nozzle for an internal combustion engine fuel charging system of the pressure type comprising a housing a movable wall dividing said housing into opposed expansible chambers in said housing separated by said movable wall, fluid pressure connections for one of said chambers, and a valve operated by said movable wall including a movable sleeve, a valve seat in said sleeve extending diametrically thereof adjacent one end, a cylindrical guide for said sleeve having a discharge outlet connected to said one chamber, a stationary seat for said valve on one end of said guide, and means for varying the flow capacity of said discharge outlet located upstream of said valve including an opening in said sleeve controlled by the position of said sleeve with respect to said guide.

7. A pressure regulating type of fuel nozzle for an internal combustion engine fuel charging system of the pressure type comprising a housing, a movable wall dividing said housing into opposed expansible chambers in said housing separated by said movable wall, fluid pressure connection for said chambers, and a valve operated by said movable wall and controlling the discharge from one of said chambers including a sleeve on said movable wall, a valve seat at one end of said sleeve and extending diametrically thereof, a cylindrical guide for said sleeve having a discharge opening connected to said one chamber, an annular seat on said guide surrounding said opening, and means for varying the flow capacity through said discharge opening located upstream of said valve including peripherally spaced openings in said sleeve sequentially opened by movement of said sleeve with respect to said guide.

8. A pressure regulating type of fuel nozzle for an internal combustion engine fuel charging system of the pressure type comprising a housing, a movable wall dividing said housing into opposed expansible chambers in said housing separated by said movable wall, fluid pressure connections for each of said chambers, and a valve operated by said movable wall and controlling the discharge from one of said chambers including a stem operated by said movable wall, a sleeve at one end of said stem, a threaded opening in said stem communicating with said sleeve and coaxial with said sleeve and stem, a valve seat of moldable material secured in said threaded opening and having a working face extending diametrically of said sleeve, a cylindrical guide for said sleeve connected with said one chamber and having a discharge outlet, an annular valve seat on said guide surrounding said discharge outlet, and means for varying the flow capacity from said nozzle located in said sleeve.

9. A pressure regulating type of fuel nozzle for an internal combustion engine fuel charging system of the pressure type comprising a housing, a movable wall dividing housing into opposed expansible chambers in said

housing separated by said movable wall, fluid pressure connections for said chambers, and a valve operated by said movable wall including a stem, a sleeve coaxial with said stem and secured thereto, a valve seat secured on said stem by said sleeve, a cylindrical guide for said sleeve connected with one of said chambers and having a discharge outlet, an annular valve seat on said guide surrounding said discharge outlet, and separate variable orifice means for varying the flow capacity from said nozzle and controlled by movement of said sleeve.

10. A metering type of pressure regulating nozzle for the fuel charging system of an internal combustion engine having therein a tubular discharge nozzle, means forming a passage in said nozzle with inlet and outlet openings, a fluid pressure connection to said inlet opening, and a valve means for controlling said passage, said valve means comprising, a cylindrical valve guide member in said nozzle surrounding a portion of said passage, a valve seat concentric with said cylindrical valve guide member, a movable cylindrical valve operating member slidably engaging with said valve guide member, a valve concentric with said cylindrical valve operating member and movable with said member to engage with said valve seat to close said passage in said nozzle, means forming a separate variable orifice means in said valve means for metering the flow through said passage to said valve, and fluid pressure operated means connected with said valve means for opening and closing said valve means and for varying said orifice means.

11. A metering type of pressure regulating nozzle for the fuel charging system of an internal combustion engine having therein a tubular discharge nozzle, means forming a passage in said nozzle with inlet and outlet openings, a fluid pressure connection to said inlet opening, and a valve means for controlling said passage, said valve means comprising, a cylindrical guide member in said nozzle surrounding a portion of said passage, a valve seat concentric with and mounted on one end of said cylindrical valve guide member, a cylindrical sleeve member for operating said valve slidably supported on said cylindrical guide member, a valve within said sleeve member and movable with said sleeve member to engage with said valve seat to close said passage in said nozzle, means forming a separate orifice means in said sleeve member adjacent said valve seat, and fluid pressure operated means connected with said valve means for opening and closing said valve means and for varying the opening of said orifice means.

12. The combination defined in the preceding claim in which said separate orifice means are radially spaced about said sleeve and arranged in overlapping relation for variably metering the flow of fluid past said valve.

References Cited in the file of this patent

UNITED STATES PATENTS

1,363,470	Knudsen	Dec. 28, 1920
2,701,119	Smith	Feb. 1, 1955
2,774,629	Noon et al.	Dec. 18, 1956
2,782,800	Hillebrand	Feb. 26, 1957
2,785,669	Armstrong	Mar. 19, 1957