

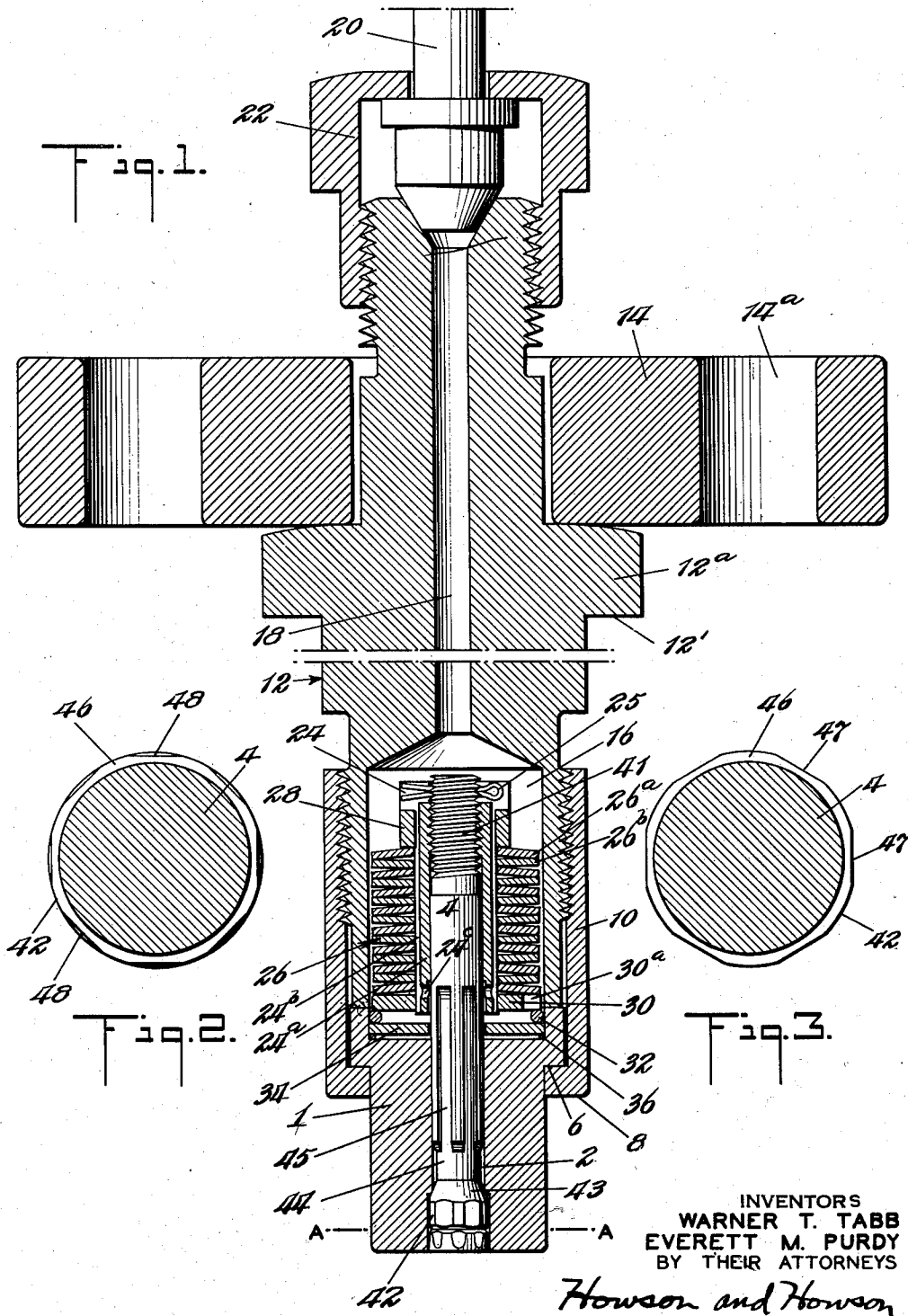
Nov. 18, 1941.

W. T. TABB ET AL
FUEL INJECTION NOZZLE

2,263,197

Filed March 8, 1939

2 Sheets-Sheet 1



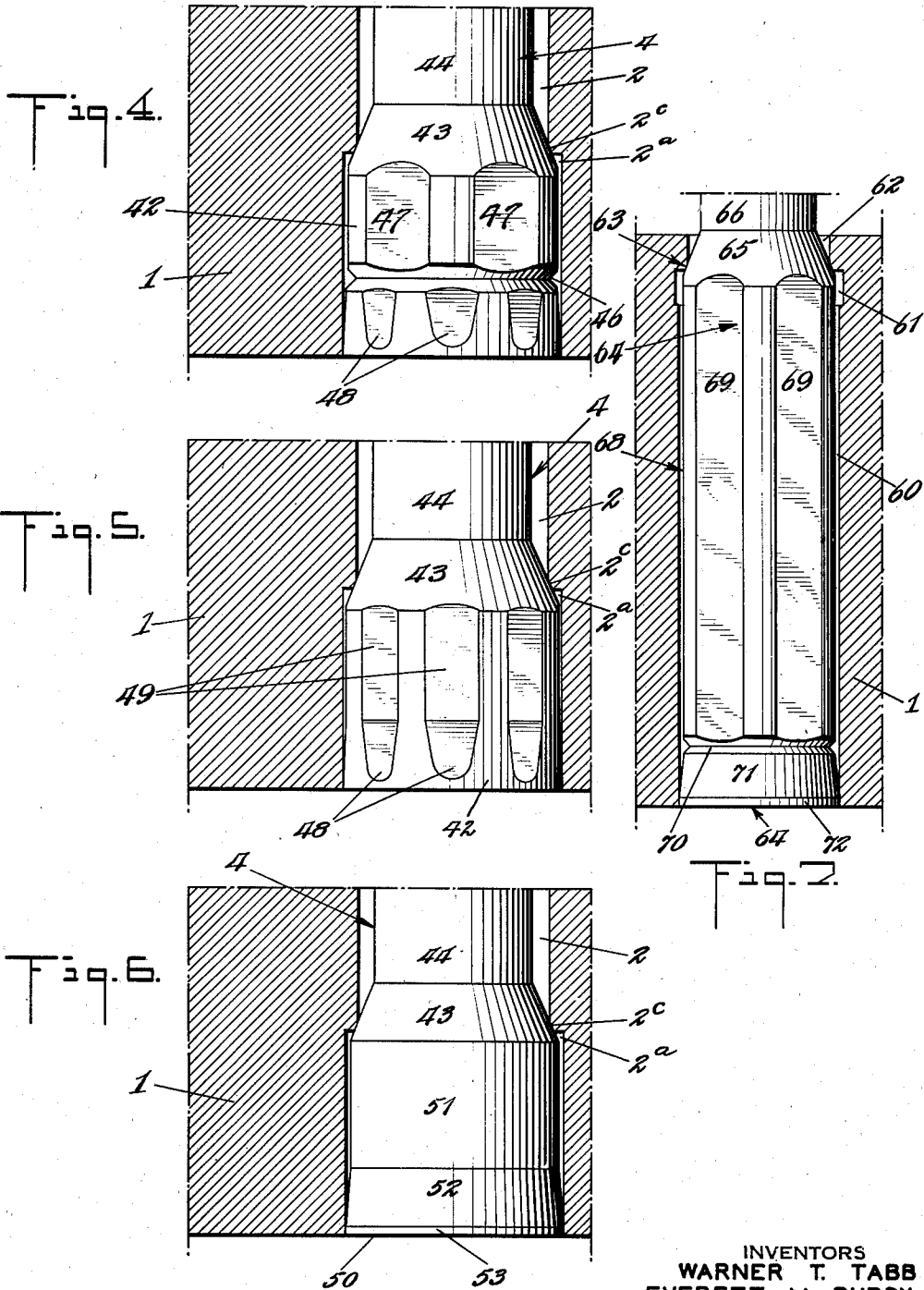
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,263,197

FUEL INJECTION NOZZLE

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Application March 8, 1939, Serial No. 260,610

19 Claims. (Cl. 299—107.6)

This invention relates to fuel injection nozzles for internal combustion engines and it is an object of this invention to provide an improved nozzle of the type described in which a valve controls the flow of fuel to the discharge orifice of the nozzle and the discharge from the nozzle is controlled by the cooperation of the stem of the controlling valve and the edge of the discharge orifice of the nozzle tip.

In the drawings:

Figure 1 is a broken longitudinal sectional view of a fuel injection nozzle constructed in accordance with this invention, the stem being shown in elevation;

Figures 2 and 3 are transverse sectional views, taken as on line A—A of Figure 1, Figure 2 being a view looking toward the discharge end of the nozzle and Figure 3 a view looking in the opposite direction;

Figure 4 is a view, similar to Figure 1 and drawn to a larger scale of a portion of the discharge end of the nozzle of Figure 1; and

Figures 5, 6 and 7 are views similar to Figure 4 of discharge nozzles having stems of modified construction.

A fuel injection nozzle constructed in accordance with this invention is shown in Figures 1 to 4 as comprising a tip member 1 having a central bore 2 to receive the stem 4 and shouldered as at 6, to be engaged by the flange 8 of the threaded collar or sleeve member 10 by which the tip 1 is secured to the nozzle holder 12. The holder 12 is arranged to fit the nozzle opening in the engine cylinder and is provided with a flange 12^a having a finished surface 12' adapted to be held against a corresponding finished surface of the engine cylinder by a clamping plate 14 which is held in engagement with the flange 12^a by means of bolts (not shown) fitting in openings 14^a of the plate 14 and threaded into the engine cylinder casting. The abutting ends of the nozzle holder 12 and the tip 1 are recessed to form a chamber 16 which is open to the bore 2 of the tip 1 and is connected by a passage 18 in the holder 12 with a fuel supply pipe 20 which is secured to the outer end of the holder 12 by a nut 22.

The stem 4 projects into the chamber 16 and is threaded at its upper end, as at 41 to receive a nut 24 which is secured in position by a cotter pin 25 engaged in a slot or groove in the nut 24 and an opening in the stem 4. The nut 24 has a skirt 24^a which fits about the stem 4 and serves as a guide for the disks of the spring 26. The spring 26 comprises alternately arranged

cupped disks 26^a and flat disks 26^b, of spring metal and of less diameter than the chamber 16. The spring 26 is confined between a collar 28 on the nut 24 and a washer 30 which surrounds the sleeve 24^a of the nut 24 and is supported at its outer edge upon a wire ring 32. The wire ring 32 is supported upon the outer edge of a spring member 34 which, in turn, is supported upon a wire ring 36 which rests upon the bottom of the recess in the tip 1. The inner edge of the spring member 34 surrounds the stem 4 in position to be engaged by the lower end of the skirt 24^a of the nut 24 and to serve as a cushioning member limiting the downward or opening movement of the stem 4 and nut 24 after the resistance of spring 26 has been overcome.

The bore 2 of the tip 1 is counterbored and made of greater diameter for a portion of its length as at 2^a, adjacent the discharge end thereof and the stem 4 has an end portion 42 of a diameter and length to substantially fit the portion 2^a of the bore 2. The portion 42 of the stem 4 is joined by a tapered or conical valve portion 43 to a portion 44 of less diameter than that of the bore 2. The conical valve portion 43 is arranged to cooperate with a correspondingly inclined seat portion of the wall of the bore 2, as at 2^c, at the junction of the portion 2^a with the remainder of the bore 2, in controlling the flow to the discharge end of the nozzle. The stem 4 is provided with grooves 45 opening to the portion 44 of the stem to permit of the flow of fuel along the stem 4 to the valve portion 43. Fuel can flow to the stem 4 from the pipe 20 by means of the passage 18 in the holder 12 to the chamber 16 and through grooves 24^b and openings 24^c in the skirt 24^a of the nut 24 to the grooves 45. Fuel in the chamber 16 can also pass along the outer edges of the disks of spring 26 and through openings 30^a in the washer 30 to the grooves 45 of the stem 4.

The end portion 42 is provided, intermediate its length, with a V-shaped distributing groove 46 which extends completely around the end portion 42. Inwardly of the distributing groove the end portion 42 is ground or cut away to provide a plurality of flat portions or surfaces 47 extending from the valve portion 43 to the distributing groove 46 and providing supply passages between the wall of the bore portion 2^a and the end portion 42 which permit of the flow of fuel from the region of the valve portion 43 to the distributing groove 46. Outwardly of the distributing groove the end portion 42 is provided with a plurality of flat surfaces 48 which extend

from the distributing groove outwardly to within a short distance of the outer end of the stem 4. The surfaces 48 gradually reduce in width towards their outer ends and are inclined, with respect to the longitudinal axis of the stem 4 so that the surfaces 48 form with the wall of the bore portion 2^a passages for the discharge of fuel from the distributing to the engine cylinder which gradually reduce in width and depth from the distributing groove 46 towards the discharge end of the nozzle. The surfaces 47, it will be noted, are wider and fewer in number than the surfaces 48 and the passages formed by the surfaces 47 and the wall of the bore portion 2^a are of greater capacity than the passages formed by the surfaces 48 and the wall of bore portion 2^a.

In the operation of the fuel nozzle described, fuel under pressure is supplied through pipe 20 and passage 18 to the chamber 16 and passes through grooves 24^b and openings 24^c, and also through openings 30^a, to the grooves 45 of the stem 4 and the bore 2 in the region of the valve portion 43 of the stem. Upon the operation of the pump placing the fuel under sufficient pressure, the unbalanced pressure of the fuel acting upon the stem 4 overcomes the resistance of the spring 26 and operates the stem 4 to separate the valve portion 43 thereof from the seat portion 2^c of the wall of the bore 2. Upon the separation of the valve portion 43 from the seat portion 2^c fuel under pressure flows past the valve portion 43 and subjects the stem 4 to additional unbalanced hydraulic pressure as it flows past the surfaces 47 to the distributing groove 46 and then past the surfaces 48 to discharge from the nozzle, the movement of the stem 4 causing the surfaces 48 to project to a greater or less extent beyond the end of the tip 1 and gradually open the passages between the surfaces 48 and the wall of the bore portion 2^a as the stem 4 is moved outwardly. Subjecting the stem 4 to the additional unbalanced hydraulic pressure upon the opening of the valve accelerates the opening movement of the valve. Movement of the stem 4 outwardly continues with the compression of the spring 26 by the fuel pressure until the lower end of the skirt 24^a of the nut 24 engages the spring member 34 and further movement outwardly of the stem 4 is prevented by the combined resistance of the springs 26 and 34. The fuel pressure at which the valve portion 43 is separated from the seat portion 2^c depends upon the initial stress given to the spring 26; that is, the extent to which the spring 26 is stressed when the valve portion 43 engages the seat portion 2^c, and this stress can be adjusted by substituting collars 28 and rings 32 of different height. The nut 24 is adjusted on the stem 4 to determine the maximum movement of the stem 4.

In the modified construction shown in Figure 5, the tip 1 is provided with a bore 2 to receive a stem 4, the lower end of the bore being of greater diameter, as at 2^a, the same as in the construction previously described. The stem 4 has the portion 44 of reduced diameter, the conical valve portion 43 which cooperates with the seat portion 2^c of the wall of the bore 2, and the end portion 42 which substantially fills the bore portion 2^a. Extending outwardly from the lower or outer edge of the valve portion 43 the end stem portion is provided with a plurality of flat surfaces 49 which extend parallel to the longitudinal axis of the stem 4 and at their outer ends are joined to flat surfaces 48 which gradually taper in width towards their outer ends and are inclined

outwardly so as to form with the wall of the bore portion 2^a passages which gradually reduce in cross-sectional area. In this construction, the surfaces 49 form supply passages of uniform cross-sectional area leading from the valve portion 43 to the discharge passages 48, there being a supply passage individual to each discharge passage.

In the modified construction shown in Figure 6 the tip 1 has the bore 2 which is enlarged, as at 2^a and the wall thereof is inclined, as at 2^c to form a valve seat and the stem 4 has a portion 44 of reduced diameter, a conical valve portion 43 and an end portion 50. The end portion 50 has a cylindrical portion 51 thereof which is of less diameter than the bore 2^a and a conical portion 52 which gradually increases in diameter outwardly from its junction with the portion 51 to the full diameter of the bore 2^a so that an annular passage of uniform cross-section is formed about the portion 51 extending from the valve portion 43 to the conical portion 52 and the conical portion 52 forms with the walls of the bore portion 2^a a discharge passage which provides a discharge opening of gradually increasing area as the stem 4 is moved outwardly beyond the end of the tip 1. The end portion 50 also comprises a cylindrical portion 53 of the full diameter of the enlarged portion 2^a of the bore and of sufficient length to extend to the face of the tip 1 when the valve portion 43 of the stem is engaged with the valve seat at 2^c.

The conical surface 52 instead of being used with a cylindrical surface 51 of less diameter than the bore 2^a as in Figure 6 can be used with flat surfaces, as the surfaces 47 and 49 of Figures 4 and 5, respectively, which flat surfaces can extend directly to the conical surface 52 in the same way surfaces 49 extend to the surfaces 48 in Figure 5 or a V-shaped groove can be interposed between the flat surfaces and the conical surface in the way the groove 46 is interposed between the surfaces 47 and 48 of Figure 4.

In the modified construction shown in Figure 7 the bore in the tip 1 is of uniform diameter for the major portion of its length inwardly from its outer end, as at 60. Adjacent its inner end the bore is enlarged for a short distance, as at 61, and then is of less diameter to the upper end of the tip, as at 62, than elsewhere in the tip. Between the portions 61 and 62 of the bore, the wall of the bore is inclined, as at 63, to form a conical valve seat. The stem 64 fitting the bore has a conical portion 65 which forms a valve co-operating with the valve seat portion 63 and connects the stem portion 66, which is of reduced diameter and extends through the disk spring, with the stem portion 68. The stem portion 68 is of a diameter to fit the bore portion 60 and is provided with flat portions 69 which extend from the conical valve portion 65 to a distributing groove 70 which encircles the stem. Outwardly from the distribution groove 70 the stem 64 is formed with a conical portion 71 which increases in diameter towards the outer end of the stem and at its end the stem is provided with a cylindrical portion 72. The stem 64 is of such length that when the conical valve portion 65 is seated on the valve seat 63 the outer face of the cylindrical portion 72 is flush with the outer face of the tip 1.

In this construction, when the stem is operated by fuel pressure the conical valve portion 65 is moved from the valve seat 63 and fuel flows

along the flat portions 69 of the stem portion 68 to the distributing groove 70. The cylindrical portion 72 restricts the discharge opening during the initial movement of the valve portion 65 from its seat and thereafter the conical portion 71 cooperates with the outer edge of the bore in forming an annular discharge opening which increases in capacity gradually as the stem moves outwardly under the pressure of the fuel.

It will be noted that in all modifications the bore in the tip member terminates in a discharge end and that the stem member outwardly of the valve has a circumambient surface portion which cooperatively makes continuous contact with a coaxially arranged circumambient portion of the surface of the bore when the valve is in closed position, effectively to close the discharge orifice provided between surfaces of the bore and stem member when the valve is opened. Though preferred, obviously these cooperating contacting bore and stem member circumambient surface portions need not be cylindrical. This secure closing of the orifice at the discharge end of the nozzle prevents undue fuel drippage after the nozzle valve is closed.

In the construction of Figure 7, the stem is always supported by the long cylindrical portion 68 of larger diameter and by the cylindrical portion 72 when the valve portion 65 is seated. In the construction of Figures 1, 4 and 5 the stem 4 is supported at all times by the grooved portion of smaller diameter and by the portion 42 of larger diameter while in Figure 6 the stem is supported at all times by the grooved portion of smaller diameter and by the cylindrical portion 53 of larger diameter only when the valve portion 43 is seated or nearly so.

In the specification and claims the term "outwardly" is used to indicate in the direction of or towards the discharge end of the nozzle while "inwardly" indicates in the direction away from the discharge end of the nozzle.

This application is a continuation in part of our prior copending applications, Serial No. 154,918, filed July 21, 1937, and now Patent No. 2,192,803, issued March 5, 1940; Serial Numbers 176,896 and 176,897, each filed November 27, 1937; the latter of which is now Patent No. 2,210,783, issued August 6, 1940.

While the several forms of the fuel injection nozzles illustrated in the drawings and described in the specification have cylindrical bores in the tip member that have normal cross-sections which are circular and the contacting guidance portion of the stem member formed with depressions, it is obvious that such arrangement could be reversed and the stem member provided with a cylindrical surface, the cross-section of which is a circle while the bore portions are cut away to provide fluted or depressed portions.

We claim:

1. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve of a

greater cross-sectional area than a cross-section of said stem through said valve, and said nozzle having a discharge orifice between peripheral surfaces of said stem and bore portions of greater cross-sectional area, said stem and bore portions outwardly of said valve having portions providing substantially concentric contacting surfaces imparting guidance during the operative movement of said stem member in said bore.

2. A nozzle of the fuel injection type comprising a tip member having a bore therein terminating in a discharge end, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by an inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore with portions of said stem and bore outwardly of said valve having a cross-sectional area greater than a section of said stem through said valve, said stem and bore portions of greater cross-sectional area having cooperating contacting surfaces comprising circumambient portions coaxially arranged outwardly of said valve, one of said enlarged stem and bore portions being substantially circular in cross-section, the other having inwardly of the circumambient contacting surface thereof at least one portion of its surface diverging inwardly away from the surface of said first-mentioned portion for providing between said portions at the discharge end of the bore a discharge orifice for said nozzle when said valve is opened, said discharge orifice being effectively closed by said cooperating circumambient contacting surfaces when said valve is in closed position.

3. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve having a cross-sectional area greater than a section of said stem through said valve, and said nozzle having a discharge orifice positioned between said stem member and the surface of a portion of said bore outwardly of said valve, said stem and bore portions outwardly of said valve being provided with portions having concentric contacting guidance surfaces, the cross-section of at least one being circular, the other having portions conforming with circular arcs.

4. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by an inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being

opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore outwardly of said valve having portions providing cooperating contacting surfaces concentrically arranged imparting guidance to said stem in said bore, that of said bore being formed with a cross-sectional area greater than a section of said bore immediately inward of said valve, and said nozzle having a discharge orifice positioned at the surface of an outer portion of said bore of said greater cross-sectional area and formed as a passage between cooperating portions of said stem and bore.

5. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by an inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said bore outwardly of said valve having everywhere a cross-sectional area greater than a cross-section thereof immediately inward of said valve, said stem outwardly of said valve having portions of its surface coaxially disposed and in contacting engagement with said bore and adapted to slide therein and said nozzle having a discharge orifice formed as a fluid passage between cooperating surfaces of said stem and bore and arranged when said stem is displaced relative to said bore to provide a transverse orifice area symmetrical about the periphery of said stem and having increasing values with a valve opening movement.

6. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by an inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve having a greater cross-sectional area than a section of said bore immediately inward of said valve, said stem and said bore outwardly of said valve having portions providing contacting cooperating surfaces symmetrically arranged and providing a sliding fit of said stem portion in a portion of said bore of said greater cross-sectional area and said nozzle having a discharge orifice provided between and formed by surfaces of said stem and bore of said greater cross-sectional area at the outermost end of one of said stem and bore.

7. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by inward movement of said stem member,

said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve having a greater cross-sectional area than a cross-section of said stem through said valve, said stem and said bore outwardly of said valve having cooperating coaxial surfaces, one of which has portions providing guiding means engaging slidably with the other throughout the operative relative displacement of said stem and bore and positioned in a portion of said bore of said greater cross-sectional area, and having at least one depression therein forming with said other surface a discharge orifice for said nozzle.

8. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve having a greater cross-sectional area than a cross-section of said stem through said valve, said stem and said bore outwardly of said valve having portions providing coaxial contacting surfaces symmetrically arranged and providing mutual guidance when said stem is sliding in a portion of said bore of said greater cross-sectional area, and additional guiding means on said stem inwardly of said valve slidably fitting said bore, said nozzle having a discharge orifice between the surfaces of said stem and bore portions of greater cross-sectional area.

9. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve of a greater cross-sectional area than a cross-section of said stem through said valve, said stem and bore portions of greater cross-sectional area having cooperative coaxial surfaces, one of which is cylindrical, the other having portions providing guiding means slidably engaging with the cylindrical surface throughout the operative relative displacement of said stem and bore, and surfaces other than those serving as guiding means converging outwardly in a manner approaching engagement for providing a discharge orifice for said nozzle in line with an element of said cylindrical surface, said stem and bore being formed to provide a net effective area exposed to fluid pressure tending to open said valve which is greater when said valve is partly open than when said valve is closed.

10. A nozzle of the fuel injection type com-

prising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve of a greater cross-sectional area than a cross-section of said stem through said valve, said stem and said bore outwardly of said valve having cooperative coaxial surfaces, one of which is cylindrical, and other having portions providing guiding means slidably engaging with the cylindrical surface throughout the operative relative displacement of said stem and bore, and surfaces other than those serving as guiding means converging outwardly in a manner approaching engagement for providing a discharge orifice for said nozzle discharging in line with an element of said cylindrical surface, said stem portion of greater cross-sectional area providing a net effective area exposed to fluid pressure acting in a direction to open said valve which is greater in all open positions of said valve than in the closed position thereof.

11. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve of a greater cross-sectional area than a cross-section of said stem through said valve, and said stem and bore portions of greater cross-sectional area having cooperative coaxial surfaces, one of which is cylindrical, the other having portions providing guiding means slidably engaging with the cylindrical surface throughout the operative relative displacement of said stem and bore, and surfaces other than those serving as guiding means converging outwardly in a manner approaching engagement for providing a discharge orifice for said nozzle, said surface portions which serve as guiding means having sliding contact in the same transverse plane with said cylindrical surface at said discharge orifice during discharge from said orifice.

12. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve of a

greater cross-sectional area than a cross-section of said stem through said valve, said stem and said bore outwardly of said valve having cooperative coaxial surfaces, the surface of said bore being cylindrical, the surface of said stem having portions providing guiding means slidably engaging with the cylindrical surface throughout the operative relative displacement of said stem and bore, and surfaces other than those serving as guiding means converging outwardly in a manner approaching engagement for providing a discharge orifice for said nozzle at the point of convergence, said converging surfaces being shaped at such point to be substantially cylindrical to form an annular orifice which increases in area with valve opening movement.

13. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve of a greater cross-sectional area than a cross-section of said stem through said valve, said stem and bore portions outwardly of said valve having cooperative coaxial surfaces, one of which is cylindrical, the other having portions providing guiding means slidably engaging with the cylindrical surface throughout the operative relative displacement of said stem and bore, and surfaces other than those serving as guiding means converging outwardly in a manner approaching engagement for providing a discharge orifice at the point of convergence of said surfaces, said guiding means being arranged to provide sliding contact at said discharge orifice and in the same transverse plane therewith.

14. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve of a greater cross-sectional area than a cross-section of said stem through said valve, said stem and bore portions outwardly of said valve having cooperative coaxial surfaces, the surface of said bore being cylindrical, the surface of said stem having portions providing guiding means slidably engaging with the cylindrical surface throughout the operative relative displacement of said stem and bore, and surfaces other than those serving as guiding means converging outwardly in a manner approaching engagement for providing a discharge orifice at the point of convergence of said surfaces, said discharge orifice having the effective cross-sectional area thereof gradually increased upon movement of said stem in the direction of fuel discharge.

15. A nozzle of the fuel injection type comprising a tip member having a bore therein, a stem member slidably mounted in said bore, said tip and stem members having cooperating shoulders forming a valve in said bore intermediate the length of said stem member, spring means positioned inwardly of said valve for closing said valve by inward movement of said stem member, said valve when closed preventing flow of fuel for discharge from said nozzle and being opened in the direction of fuel discharge by fuel pressure, said cooperating shoulders providing enlargements of said stem and bore, said stem and bore having portions outwardly of said valve of a greater cross-sectional area than a cross-section of said stem through said valve, said stem and bore portions outwardly of said valve having cooperative coaxial surfaces, the surface of said bore being cylindrical, the surface of said stem having portions providing guiding means slidably engaging with the cylindrical surface throughout the operative relative displacement of said stem and bore, and surfaces other than those serving as guiding means converging outwardly in a manner approaching engagement for providing a discharge orifice at the point of convergence of said surfaces, said discharge orifice being effectively closed by said contacting surfaces when said valve is in closed position and having a gradually increasing effective cross-sectional area as said valve is moved from its closed position.

16. A nozzle of the fuel injection type comprising a tip member having a bore therein, the outer end of which is counterbored a desired distance providing a shoulder therein intermediate the ends of said bore, a stem member disposed in said bore and provided with a reduced inwardly projecting portion, an intermediate portion forming a valve seating inwardly on said shoulder and an outer portion slidably fitted into said counterbore and providing contacting guidance for said stem member, said outer portion being formed with at least one depressed portion having a relatively slight outwardly flaring taper whereby an orifice for the outward passage of fuel is provided which increases in area with outward movement of said stem member, and spring means at the inner end of said tip member associated with said inwardly projecting portion for normally retracting the latter and seating said valve.

17. A nozzle of the fuel injection type comprising a tip member having a bore therein, the outer end of which is counterbored a desired distance providing a shoulder therein intermediate the ends of said bore, a stem member disposed in said bore and provided with a reduced inwardly projecting portion, an intermediate portion forming a valve seating inwardly on said shoulder and an outer portion slidably fitted into said counter-

bore and providing contacting guidance for said stem member, said outer portion having a fuel distributing groove disposed peripherally about the same and formed with a plurality of depressed portions having a relatively slight outwardly flaring taper whereby an orifice for the outward passage of fuel is provided which increases in area with outward movement of said stem member, and spring means at the inner end of said tip member and associated with said inwardly projecting portion of said stem member for normally retracting the latter and seating said valve.

18. A nozzle of the fuel injection type comprising a tip member having a bore therein, the outer end of which is counterbored a desired distance providing a shoulder therein intermediate the ends of said bore, a stem member disposed in said bore and provided with a reduced inwardly projecting portion, an intermediate portion forming a valve seating inwardly on said shoulder and an outer portion slidably fitted into said counterbore and providing contacting guidance for said stem member, said outer portion being formed with at least one depressed portion having a relatively slight outwardly flaring taper whereby an orifice for the outward passage of fuel is provided which increases in area with outward movement of said stem member, said reduced portion having additional guidance means cooperating with the reduced portion of said bore, and spring means at the inner end of said tip member associated with the inwardly projecting portion of said stem member for normally retracting the latter and seating said valve but opening the same for a predetermined pressure of the fuel.

19. A nozzle of the fuel injection type comprising a tip member having a bore therein, the outer end of which is counterbored a desired distance providing a shoulder therein intermediate the ends of said bore, a stem member disposed in said bore and provided with a reduced inwardly projecting portion, an intermediate portion forming a valve seating inwardly on said shoulder and an outer portion slidably fitted into said counterbore and providing contacting guidance for said stem member, said outer portion being formed with a plurality of depressed portions having a relatively slight outwardly flaring taper whereby an orifice for the outward passage of fuel is provided which increases in area with outward movement of said stem member, said outer portion of said stem member being terminated flush with the outer end surface of said tip member, and spring means at the inner end of said tip member associated with said inwardly projecting portion for normally retracting the latter and seating said valve.

WARNER T. TABB.
EVERETT M. PURDY.

DISCLAIMER

2,263,197.—*Warner T. Tabb*, Brooklyn, N. Y., and *Everett M. Purdy*, New Canaan, Conn. FUEL INJECTION NOZZLE. Patent dated November 18, 1941. Disclaimer filed July 3, 1942, by the mortgagee, *The Seymour Corporation of Delaware*.

Hereby to the extent of its interest enters this disclaimer to claim 2 of said patent.

[*Official Gazette August 4, 1942.*]

CERTIFICATE OF CORRECTION.

Patent No. 2,263,197.

November 18, 1941.

WARNER T. TABB, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, first column, line 18, claim 10, for "and" read --the--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of December, A. D. 1941.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.