Nov. 7, 1967 J. P. PERR 3,351,288

FUEL INJECTOR

Filed March 25, 1964 2 Sheets-Sheet 1

Fig. 2.

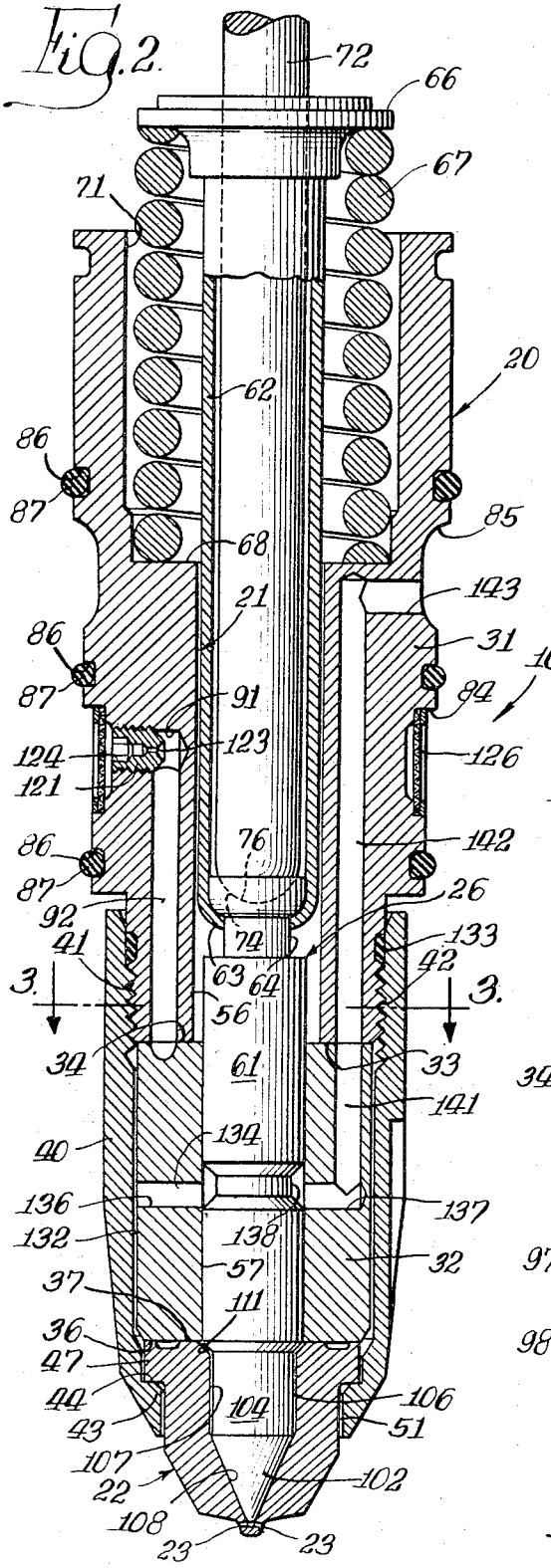


Fig. 1.

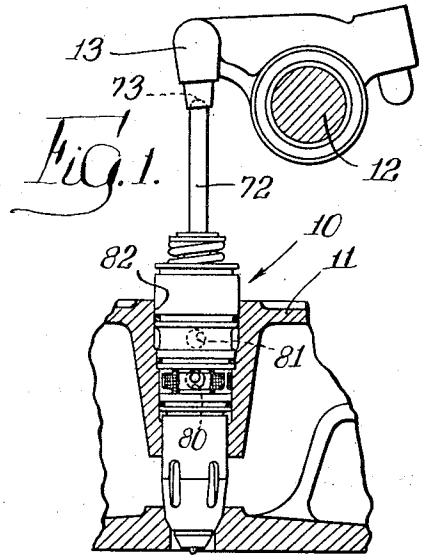


Fig. 3.

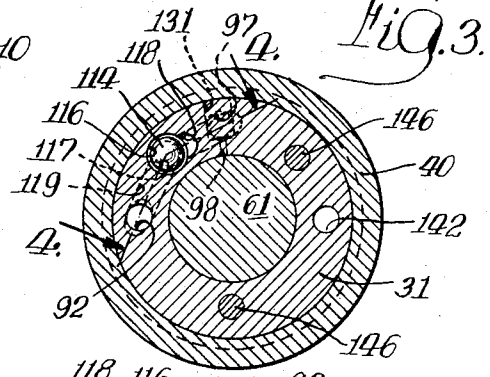
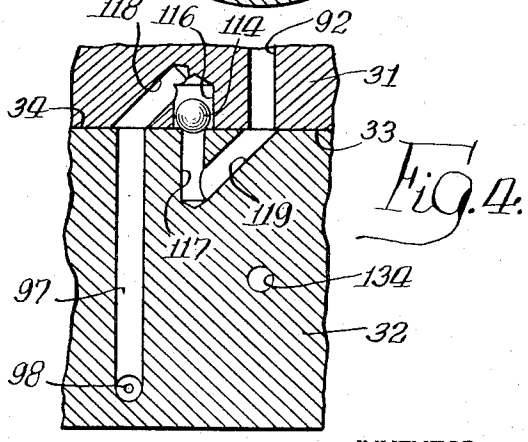


Fig. 4.



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FUEL INJECTOR

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Fig. 5.

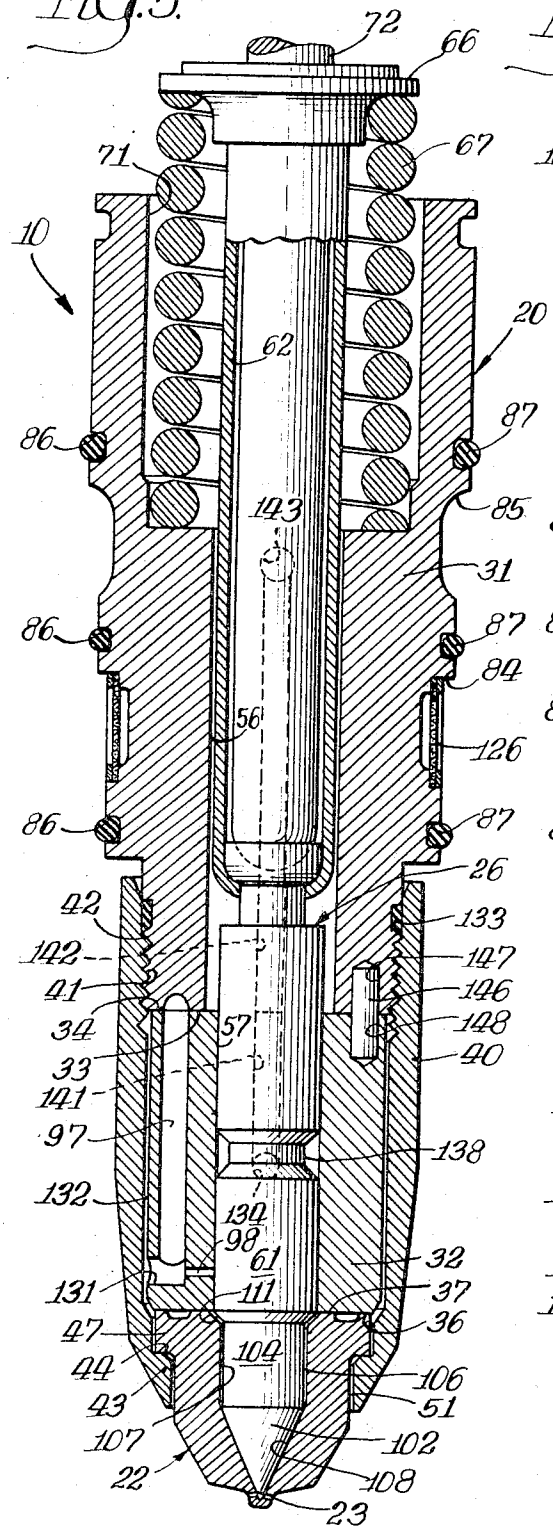
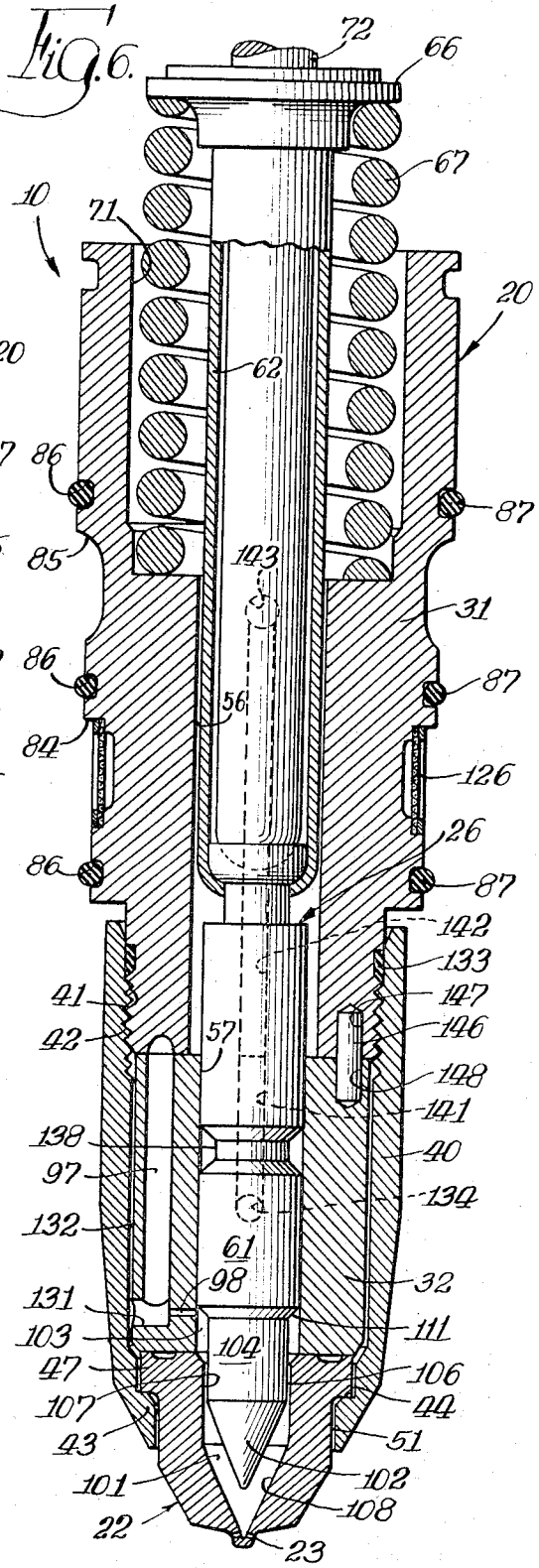


Fig. 6.



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3,351,288

FUEL INJECTOR

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Filed Mar. 25, 1964, Ser. No. 354,572
18 Claims. (Cl. 239—89)

This invention relates generally to fuel injectors for internal combustion engines and more particularly to a fuel injector for a compression ignition engine.

The general object of the invention is to provide a fuel injector having novel means for substantially preventing products of combustion from entering the injector and passing to critical parts thereof or to fuel lines connected to the injector.

Another object is to provide a fuel injector having a novel arrangement for the flow of fuel therethrough.

A further object is to provide an injector construction in which the portions normally subjected to wear and deterioration can be readily replaced without replacement of the whole injector.

Still another object is to provide an injector construction having a plunger of the type operated by a rocker arm for injecting the fuel into the cylinder, wherein any side thrust on the plunger from the movement of the rocker arm is reduced.

A still further object is to provide an injector construction provided with passages for the flow of fuel formed by drilling bores in the body of the injector, the construction being such that none of said bores require plugging to close an end of any such bore.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary view on a reduced scale of an internal combustion engine having an injector embodying the features of the invention;

FIG. 2 is a longitudinal sectional view through the injector shown in FIG. 1;

FIG. 3 is a transverse sectional view taken on the line 3—3 of FIG. 2;

FIG. 4 is a fragmentary sectional view taken on the line 4—4 of FIG. 3;

FIG. 5 is a longitudinal sectional view similar to FIG. 2 but taken in a plane differing from that of FIG. 2; and

FIG. 6 is a view similar to FIG. 5 but showing the parts of the injector in a different position, during operation, from the position of the parts shown in FIG. 5.

An injector embodying the features of the invention comprises generally an injector body having a plunger bore and a nozzle at one end of the plunger bore, through which fuel is injected into the cylinder of the engine by a plunger reciprocably mounted in the bore. The body also has a fuel passage comprising a supply portion adapted to be connected at one end to a source of fuel under pressure and at its other end a feed hole connecting the passage with the plunger bore, The feed hole being opened and closed by reciprocation of the plunger. The plunger adjacent one end and the portion of the body surrounding such end portion of the plunger is formed to provide two chambers, one communicating with the nozzle and the other communicating with the feed hole, with a restricted conduit or clearance connecting the two chambers and substantially preventing passage of combustion products from the chamber communicating with the nozzle to the chamber communicating with the feed hole, fuel being forced through said clearance from the last mentioned chamber to the first mentioned chamber during a part of the cycle of operation and tending to flush out any carbon which may have

collected in the clearance. The body also includes a return portion of the passage therethrough, which return portion is adapted to be closed by the plunger when the feed hole is opened thereby.

The body of the injector is formed by a plurality of parts arranged so that those parts subjected to greatest wear may be readily replaced without replacement of the whole injector. Further, such parts are provided with drilled bores constituting the above mentioned supply and return portions. The fact that the body comprises a plurality of parts permits such bores all to be drilled from an outer surface of any such part without the necessity of plugging any such bore at an end thereof. A part of the return portion is formed merely by providing a clearance between two of the body parts to avoid the necessity of a drilled bore for such part of the return portion.

The plunger for injecting the fuel from the injector into the cylinder is adapted to be actuated on its injection stroke by engine operated means including a rocker arm the movement of which is generally longitudinally of the plunger but has a component laterally of the plunger. Such lateral component would tend to cause unwanted wear on the plunger or in the plunger bore of the body. For this reason, the plunger has a construction which reduces any lateral thrust on the plunger itself so that wear from such lateral thrust is avoided.

In FIG. 1 of the drawings there is shown an injector, indicated generally at **10**, mounted in an engine fragmentarily shown. The engine of course may have a plurality of cylinders although one one cylinder is shown. Thus, the engine includes a cylinder head **11**, a rock shaft **12** and a rocker arm **13** adapted to be rocked on the rock shaft by the usual engine driven means.

The injector **10**, embodying the features of the invention, comprises an elongated injector body indicated generally at **20** and having a plunger bore **21** therethrough, and a nozzle member or cup **22** having nozzle opening **23** therein through which fuel is injected into the cylinder of the engine. A plunger, indicated generally at **26**, is reciprocably mounted in the bore **21** for ejecting a quantity of fuel from a chamber in the body **20** upon movement of the plunger **26** toward the nozzle.

The injector body **20**, in the present instance, comprises a generally cylindrical body member or adapter **31**, a barrel member **32**, and the nozzle member **22** arranged in end-to-end abutting relation. Thus, the abuting end faces, indicated at **33** and **34**, of the body and barrel members **31** and **32**, respectively, and the abutting end faces, indicated at **36** and **37**, of the barrel and nozzle members **31** and **22**, respectively, are machined flat to assure surface to surface contact when the parts are engaged.

For holding the parts of the injector body **20** in assembled end-to-end relation, a tubular retainer **40** is provided. The retainer **40** in the present instance is internally threaded as at **41** at one end for engagement with external threads **42** on the end of the body member **31**, as viewed in FIGURE 2. The other end of the retainer **40** is provided with an inturned flange **43** defining an internal shoulder **44** for engaging an annular radially outwardly extending flange **47** on the nozzle member **22**. Thus, when the retainer **40** is threaded onto the body member **31**, the end faces **33**, **34** and **36**, **37** of the parts of the injector body **20** are held in abutting engagement.

As heretofore mentioned, the injector body **20** is provided with a bore **21** for receiving the plunger **26**. The bore **21**, in the present instance, comprises a portion **56** in the body member **31** and a coaxial portion **57** in the barrel member **32**, the portion **56** being of somewhat larger diameter than the portion **57** so that the upper end of the

plunger **26** does not contact the wall of the bore **56**. The interior of the nozzle member **22** constitutes a continuation of the plunger bore **21**.

The plunger **26**, in the present instance, comprises a fuel injecting and control member **61** and a sleeve **62**. One end, indicated at **63**, of the sleeve **62** is secured to the adjacent end of the plunger member **61** by rolling or otherwise forming the end **63** into a circumferential groove **64** formed on the end of the plunger portion **61**. The outside diameter of the sleeve **62** is somewhat less than that of the portion **56** of the plunger bore so that the sleeve fits loosely within the bore **56** throughout the range of movement of the plunger. A flange **66** is secured to the other end of the sleeve **62** to provide an abutment for one end of spring means in the form of a coil spring **67** disposed around the sleeve **62**. The other end of the coil spring **67** bears against a shoulder **68** defined by an enlarged bore **71** in the end of the body member **31**, which is coaxial with the bore **56**. The spring **67** is normally under compression and thus serves to urge the plunger **26** away from the nozzle.

Movement of the plunger **26** toward the nozzle member **22** is effected by the rocker arm **13** acting through an elongated rod-like member or link **72**. In the present instance, one end, indicated at **73** (FIG. 1), of the link **72** is spherically formed for engaging a complementally shaped seat at one end of the rocker arm **13**, and the other end, indicated at **74** (FIG. 2), of the link **72** is spherically formed and engages a complementally shaped seat **76** in the end of the plunger member **61**. Such engagement substantially eliminates the imposition of side thrust on the plunger member **61**. Such side thrust is further reduced due to the fact that the link **72** is of substantial length so that the angular movement of the link **72** is relatively small.

The reduction of side thrust from the rocking movement of the rocker arm on the plunger member **61** substantially reduces wear between the plunger member **61** and the bore portion **57**, thereby increasing the service life of the injector.

As heretofore mentioned, the injector body **20** is provided with a fuel passage therethrough, comprising a supply portion and a return portion. One end of the supply portion is adapted to be connected to a fuel supply line, and one end of the return portion is adapted to be connected to a fuel return line. Such fuel supply and return lines, in the present instance, comprise a pair of spaced longitudinally extending bores **80** and **81** (FIG. 1), respectively, in the cylinder head **11**. The fuel supply bore **80** has one end connected to a source of fuel under pressure, such as a fuel pump, and the fuel return bore **81** which may be connected to the low pressure side of the fuel pump, is provided for returning a portion of the fuel supplied to the injector to the pump. The fuel supply and return bores **80** and **81** intersect a vertical mounting bore, indicated generally at **82**, in the cylinder head **11**, the bore **82** comprising a series of concentric bores of varying diameters. The injector body **20** similarly includes a series of concentric, varying diameter portions adapted to engage the concentric portions of the mounting bore **82** to thus locate the injector in the cylinder head **11**. When fully seated in its bore **82**, the fuel supply and return bores **80** and **81** register with circumferential grooves **84** and **85**, respectively, in the body member **31**. In order to prevent fuel leakage between the fuel supply bore **80** and fuel return bore **81**, the body member **31** may include a plurality of longitudinally spaced grooves **86** for receiving O-ring seals **87**, there being at least one groove and seal on each side of each of the supply and return grooves **84** and **85**.

The supply portion of the fuel passage, in the present instance, comprises a transverse bore **91** (FIG. 2) extending inwardly from the groove **84**, the inner end of which opens into one end of a longitudinal bore **92**. The bore **92** extends to the end face **33** of the body member **31**, and communicates with one end (FIGS. 4, 5 and 6) of a longitudinal bore **97** in the barrel member **32**, which is laterally offset from the bore **92**. The other end of the bore **97** is spaced from the end of the barrel member **32** and is connected to a small transverse bore or feed hole **98** in the barrel member, the inner end of the feed hole **98** opening into the portion **57** of the plunger bore **21**. Thus, the supply portion of the fuel passage includes the transverse bore **91**, connected but laterally offset longitudinal bores **92** and **97**, and the feed hole **98**.

According to the present invention, the plunger member **61**, as viewed in FIG. 6, and the plunger bore **21**, including that portion thereof in the interior of the nozzle member **22**, is formed to define two chambers. Thus, the plunger member **61** and the nozzle member **22**, when the plunger member is moved away from the nozzle, are shaped to provide a space within the plunger bore communicating with the nozzle openings **23** and the feed hole **98**. Such space, in the present instance, comprises an injection chamber **101** defined by the interior of the nozzle member **22** and the end of the plunger member **61**, and another chamber **103** defined by a reduced diameter portion **104** on the plunger member **61** and the adjacent wall of the plunger bore portion **57**. The chambers **101** and **103** are connected by a restricted conduit **106** defined between the reduced diameter portion **104** and the adjacent wall, indicated at **107**, of the interior of the nozzle member **22**. In the present instance, the reduced diameter portion **104** and wall **107** are cylindrical so that a clearance therebetween provides the restricted conduit **106**. The end of the plunger member **61**, indicated at **102**, is tapered to fit a complementally tapered internal surface **108** in the nozzle member **22**. The reduced diameter portion **104** also defines a shoulder **111** which is effective to open and close the feed hole **98** upon movements of the plunger **26** in its bore.

According to the present invention, the restricted conduit or clearance space **106** is small and preferably about .003 inch in radial width. Such restricted conduit provides a significant operational advantage in that combustion products, such as carbon particles, which may be forced through the nozzle openings **23** into the chamber **101** are prevented for the most part from entering the chamber **103** and feed hole **98**. Thus, carbon particles are deposited upon the adjacent walls of the restricted conduit **106**, rather than being carried into the chamber **103** or feed hole **98**, or even possibly to the supply and return portions of the fuel passage. The tendency for the carbon particles to accumulate on the walls of the restricted conduit **106** is minimzed by the high velocity flow of fuel therethrough from the chamber **103** into the injection chamber **101** upon movement of the plunger **26** toward the nozzle. Moreover, even though some carbon may accumulate on the reduced portions **104** and **107**, such accumulation does not substantially affect operation of the injector. Further, the prevention of accumulation of carbon particles in the area of the feed hole prevents scratching or serration of the plunger member **61** and hence deterioration of the plunger member **61** in the area of the shoulder **111** and the plunger bore in the area of the feed hole **98**. Moreover, since the products of combustion are substantially prevented from passing through the restricted clearance **106**, there is less back flow of such products through the nozzle openings **23**.

The restricted conduit **106** also provides another advantage where a plurality of injectors are employed, such as in a multi-cylinder engine, wherein the injectors are supplied in common by the supply and return bores **80** and **81** (FIG. 1). Thus, because of the fact that, when the feed hole **98** is uncovered by the shoulder **111**, the supply portion of the fuel passage in a particular injector will be in communication with the common supply bore **80**, a pressure wave from the cylinder could be transmitted through the supply portion of the fuel passage to the common supply bore and possibly adversely affect the

metering of fuel in adjacent injectors. The restricted conduit **106** to some extent acts as a barrier to the passage of such pressure wave and thus eliminates this problem.

As a further precaution to the passage of such pressure waves into the common fuel supply bore **80** valve means in the form of a check valve may be provided in the supply portion of the fuel passage, between the feed hole **98** and fuel inlet groove **84**. Such valve means, in the present instance, comprises a ball check valve **114** (FIGS. 3 and 4) mounted in a cavity formed in one of the members comprising the body, in this instance in the body member **31**. Such cavity, in the present instance, is formed by a bore **116** extending inwardly from the end face **33** of the body member. A bore **117** coaxial with the bore **116** and of somewhat smaller diameter than the ball **114** extends inwardly from the end face **34** of the barrel member **32** and provides a seat for the ball **114**. The inner end of the bore **116** is intersected by a short diagonal bore **118** which opens in the end face **33** in the registry with the longitudinal bore **97**. The inner end of the bore **117** is intersected by one end of another diagonal bore **119** in the barrel member **32**, which extends to the end face **33** in registry with the longitudinal bore **92**. Thus, should the pressure wave, or the affect thereof, pass through the restricted conduit **106** and progress upstream in the supply portion of the fuel passage, such wave would cause the ball **114** to seat and prevent further passage of the wave in the fuel passage. Such seating of the ball is of course assisted by gravity acting on the ball **114** when in the injector is positioned with its nozzle at the lower end thereof. In some instances, the ball valve **114** may not be necessary because of the prevention of back flow by the restricted clearance **106**.

In order to supply a metered quantity of fuel through the feed hole **98** to the injection chamber **101** for injection into the cylinder, flow control means is provided in the supply portion of the fuel passage. Such flow control means in the present instance comprises a plug **121** (FIG. 2) threaded into the outer end of the transverse bore **91**. The plug **121** is provided with a metering orifice **123** therethrough for metering fuel into the supply portion of the passage in the injector and through feed hole **98**. The plug **121** may be provided with a socket portion **124** adapted to receive a tool to facilitate installation or removal thereof. A screen **126** may be disposed in the groove **84** to prevent foreign particles from entering the fuel passage.

As heretofore mentioned, the fuel passage also includes a fuel return portion for returning excess amounts of fuel to the fuel return bore **81**. Such fuel return portion in the present instance, comprises a transverse bore **131** (FIGS. 5 and 6) connected at its inner end with the longitudinal bore **97** of the supply portion, preferably coaxial with the feed hole **98**. The transverse bore **131** is spaced from the end face **36** of the barrel member **32** so that there is a substantial body of metal radially outside of the metal between the feed hole **98** and the end face **36**. Thus, when movement of the plunger **26** toward the nozzle openings **23** builds up a high pressure in the chambers **101** and **103** to effect injection, radially outward expansion of the metal between the feed hole **98** and the end face **36** is substantially prevented because of the backing provided by the metal between the transverse bore **131** and the end face **36** and the fact that the longitudinal bore **97** terminates at a point spaced from the end face **36**. The outer end of the of the transverse bore **131** opens into an annular space **132** provided between the barrel member **31** and the tubular retainer **40**. The annular space **132** thus comprises a part of the return portion of the fuel passage. An annular seal, such as an O-ring **133**, may be provided to prevent fuel leakage between the end of the body member **31** and the tubular retainer **40**.

The fuel return portion further includes a transverse hole or bore **134** (FIG. 2) in the barrel member **32**, the hole **134** extending from the space **132** and intersecting the portion **57** of the plunger bore and being spaced from the transverse bore **131**. Thus, the hole **134** has a portion **136** on one side of the bore portion **57** communicating with the annular space **132**, and another portion **137** on the opposite side of the portion **57**. The portions **136** and **137** of the transverse hole **134** are adapted to be connected by a circumferential groove **138** formed in the plunger member **61**, when the plunger is in its fully advanced position toward the nozzle, as illustrated in FIGS. 2 and 5. The groove **138** thus comprises another part of the return portion of the fuel passage.

A longitudinal bore **141** in the barrel member **32** intersects the portion **137** of the transverse hole **134** and communicates with another longitudinal bore **142** in the body member **31**, the bore **142** being connected to the inner end of another transverse bore **143** which opens into the groove **85**. Thus, the return portion of the fuel supply passage comprises the transverse bore **131**, annular space **132**, transverse hole **134**, groove **138** in the plunger portion **161**, the longitudinal bores **141** and **142**, and transverse bore **143**.

The groove **138** is so positioned on the plunger member **61** as to close the transverse hole **134**, and consequently the return portion of the fuel passage, before the shoulder **111** uncovers the feed hole **98**. The return portion of the fuel passage thus permits a circulating flow of fuel through the fuel passage in the injector to purge the passage of air or combustion products so that a solid flow of fuel is applied to the chamber **103** for delivery to the injection chamber **101** upon movement of the plunger **26** toward the nozzle. The provision of the annular space **132**, in addition to forming a part of the return portion of the fuel passage, also provides a cooling effect on the parts of the injector adjacent the space **132** because of the aforementioned fuel circulation therethrough.

The foregoing construction provides certain other advantages over other injector constructions from the standpoint of increased service life and economy of manufacture. Thus because of the fact that the injector body **20** is formed by plurality of parts, those parts which are subjected to the greatest wear may be readily replaced without replacement of the entire injector. Thus, the nozzle member **22** and the barrel member **32** may be readily replaced on removal of the retainer **40**.

To facilitate proper alignment of the tapered interior **108** of the nozzle member **22** and the tapered end **102** of the plunger member **61**, the internal surface portions of the retainer **40** and the complementary peripheral portions of the nozzle member **22** are dimensioned so that a slight clearance is provided therebetween. Such clearance permits the nozzle member **22** to be shifted with respect to the barrel member **32** to assure accurate alignment of the tapered end **102** and the complementally tapered surface **108**. Such alignment is readily achieved by causing the plunger **26** to move to its fully advanced position in the bore **26**, as illustrated in FIGS. 2 and 5, and then positioning the nozzle member **22** on the barrel member **32** with the tapered portions properly engaged and subsequently drawing up the tubular retainer **40**. Accurate alignment of the barrel member **32** with the body member **31** is assured by the provision of a pair of dowel pins **146** (FIG. 3) only one of which is shown in FIGS. 5 and 6.

The foregoing multiple part construction permits all of the various bores in the injector to be drilled from an outside surface thereby eliminating the necessity of plugging the opposite end of any such bore. The overall cost of the injector is thus reduced and the construction thereof simplified.

I claim:

1. An injector for injecting fuel into a cylinder of an internal combustion engine, comprising an injector body having a plunger bore and a nozzle opening at one end of said plunger bore, said body also having a fuel

passage adapted to be connected to a source of fuel under pressure and having a feed hole connecting said passage with said bore, and a plunger reciprocably mounted in said bore for opening and closing said feed hole and movable toward said nozzle opening to eject fuel through said nozzle opening, said plunger being movable away from said nozzle opening to provide space within said bore communicating with said nozzle opening and said feed hole, said plunger and said bore being formed to provide a restricted conduit therebetween located between said nozzle opening and said feed hole, said space thereby having a portion adjacent said nozzle opening and another portion adjacent said feed hole, said conduit being located between said portions and having a smaller sectional area than either of said portions and thereby substantially preventing passage of combustion products from said one portion to said other portion.

2. The fuel injector according to claim 1, in which said plunger when moved toward said nozzle opening closes said feed hole and forces fuel from said other portion through said restricted conduit to said one portion and also forces fuel through said nozzle opening.

3. An injector for injecting fuel into a cylinder of an internal combustion engine, comprising an injector body having a plunger bore and a nozzle opening at one end of said plunger bore, said body also having a fuel passage adapted to be connected to a source of fuel under pressure and having a feed hole connecting said passage with said bore, a plunger reciprocably mounted in said bore for opening and closing said feed hole and movable toward said nozzle opening to eject fuel through said nozzle opening, said plunger and said body being formed to provide an injection chamber between the end of said plunger and said nozzle opening and to provide another chamber around said plunger and communicating with said feed hole when said plunger is moved in one direction, said body and said plunger also being formed to provide a restricted conduit between said plunger and said body connecting said chambers, said conduit substantially preventing passage of combustion products into said other chamber.

4. An injector for injecting fuel into a cylinder of an internal combustion engine, comprising an injector body having a plunger bore and a nozzle opening at one end of said plunger bore, said body also having a fuel passage adapted to be connected to a source of fuel under pressure and having a feed hole connecting said passage with said bore, a plunger reciprocably mounted in said bore for opening and closing said feed hole and movable toward said nozzle opening to eject fuel through said nozzle opening, said plunger and said body being formed to provide an injection chamber between the end of said plunger and said nozzle opening and to provide another chamber around said plunger and communicating with said feed hole when said plunger is moved in one direction, said plunger having a cylindrical portion of reduced diameter adjacent said one end thereof, and said bore having a reduced diameter cylindrical portion cooperating with said reduced diameter portion of said plunger to provide a restricted conduit between said plunger and said body connecting said chambers, said restricted conduit substantially preventing passage of combustion products into said other chamber.

5. A fuel injector according to claim 4, in which said reduced diameter portion of said plunger provides a shoulder on said plunger for opening and closing said feed hole.

6. A fuel injector according to claim 5, in which said injector body includes a barrel member having said plunger bore and said passage extending therethrough and having said feed hole therein, and a cup mounted in end-to-end relation with said barrel member and secured thereto, said cup having said nozzle opening therein and having its interior dimensioned to provide said restricted conduit.

7. A fuel injector according to claim 6, in which said injection chamber is provided in said cup, and said other chamber is provided in said barrel.

8. A fuel injector according to claim 4, in which said reduced diameter portion of said plunger is smaller than the reduced diameter portion of said bore to provide said restricted conduit.

9. A fuel injector according to claim 4, in which said reduced diameter portion of said plunger forms said other chamber with said bore beyond said reduced diameter portion of said bore.

10. An injector for injecting fuel in a cylinder of an internal combustion engine, comprising an injector body having a plunger bore and a nozzle opening at one end of said plunger bore, and a tubular member enclosing a portion of said injector body, said injector body also having a fuel passage including a supply portion having one end adapted to be connected to a fuel supply line and a feed hole at its other end connecting said supply portion with said plunger bore, and a return portion adapted to be connected to a fuel return line, and a plunger reciprocably mounted in said plunger bore for opening and closing said feed hole and movable toward said nozzle opening for ejecting fuel through said nozzle opening, said tubular member being spaced from and defining a space around said portion of said injector body and said return portion being connected to said other end of said supply portion and including said space.

11. A fuel injector according to claim 10, in which said injector body includes a cylindrical barrel member and a nozzle member, said tubular member comprising a retainer for securing said nozzle member in end-to-end relation with said barrel member, said barrel member having said supply portion and said return portion extending therethrough, and a portion of said retainer and said barrel member providing said space therebetween, said space being annular in form and extending for the full length of said barrel member.

12. A fuel injector according to claim 11, in which said annular space communicates with said other end of said supply portion, and said barrel member has a transverse hole communicating with said annular space and forming part of said return portion.

13. A fuel injector according to claim 11, in which said injector body comprises a body member having threads at one end and said barrel member and said nozzle member, said barrel member being interposed between said body member and said nozzle member, said retainer having internal threads at one end engaging the threads on said body member, and said retainer at its other end having an inturned flange engaging said nozzle member and holding said nozzle member, said barrel member and said body member in end-to-end relation.

14. An injector for injecting fuel into a cylinder of an internal combustion engine, comprising an injector body having a plunger bore and a nozzle opening at one end of said plunger bore, said injector body having a fuel passage including a supply portion having one end adapted to be connected to a fuel supply line and a feed hole at its other end connecting said supply portion with said plunger bore, said passage also including a return portion adapted to be connected to a fuel return line and being connected to said other end of said supply portion, and a plunger reciprocably mounted in said plunger bore for opening and closing said feed hole and movable towards said nozzle opening for ejecting fuel through said nozzle opening, said injector body comprising a body member and a barrel member secured in end-to-end abutting relation to each other, said supply portion having a part in said body member and another part in said barrel member, said parts being laterally offset from each other and communicating with each other through a cavity formed in one of said members and opening at the abutting surfaces of said members, and valve means mounted in said cavity to close said supply portion when subjected to a pressure wave from said nozzle member.

15. A fuel injector according to claim 14, in which said cavity is formed in said body member and said barrel member has a hole extending from the abutting surface of said barrel member and forming a valve seat, and said valve means comprises a ball mounted in said cavity and adapted to engage said valve seat.

16. An injector for injecting fuel into a cylinder of an internal combustion engine, comprising an injector body having a plunger bore and a nozzle at one end of said plunger bore, said injector body having a fuel passage including a supply portion having one end adapted to be connected to a fuel supply line and a feed hole at its other end connecting said supply portion with said plunger bore, and a return portion adapted to be connected to a fuel return line and being connected to said other end of said supply portion, and a plunger reciprocably mounted in said plunger bore for opening and closing said feed hole and movable towards said nozzle for ejecting fuel through said nozzle, said body comprising a generally cylindrical body member, a barrel member and a nozzle member in end-to-end abutting relation, and a retainer for securing said members in said end-to-end relation, said body member having a pair of bores extending longitudinally from the abutting surface of said body member, said barrel member having a pair of bores extending longitudinally from the abutting surface of said barrel member, one of said body and barrel members having a cavity its abutting surface communicating with one of the bores in said body member and with one of the bores in said barrel member and forming said supply portion therewith, the other of said bores in said body member being aligned with the other of said bores in said barrel member, said barrel member also having a transverse bore extending from the outer peripheral surface thereof to said other bore in said barrel member and another transverse bore extending from the outer peripheral surface of said barrel member into said one bore in said barrel member adjacent said feed hole, said retainer enclosing said barrel member and being radially spaced therefrom to provide a connection between said transverse bores, said transverse bores, said space, and said other bores in said barrel member and said body member constituting said return portion, each of said bores extending from an outer surface of the member in which it is located whereby the use of plugs to close the ends of bores is avoided.

17. An injector for injecting fuel into a cylinder of an internal combustion engine, comprising an injector body

having a plunger bore and a nozzle at one end of said plunger bore, said body also having a fuel passage adapted to be connected to a source of fuel under pressure and having a feed hole connecting said passage with said bore, and a plunger reciprocably mounted in said bore for opening and closing said feed hole and movable toward said nozzle to eject fuel through said nozzle, said plunger bore having a close fit on said plunger for a portion of the length of the plunger bore, a sleeve secured at one end to said plunger and loosely fitting within said plunger bore beyond said close fitting portion and extending beyond said body, spring means coacting with said body and said sleeve for moving said plunger away from said nozzle, and a link loosely extending through said sleeve and having at one end a rocking engagement with said plunger and having its other end adapted to be engaged by a rocker arm for moving said plunger toward said nozzle.

18. A fuel injector according to claim 17, in which said body comprises a body member and a barrel member secured together in end-to-end relation, said plunger bore extending through both of said members and the portion of said plunger bore in said barrel having said close fit on said plunger, the portion of said plunger bore in said body member being enlarged, said sleeve being located in said enlarged portion of said body member and extending beyond the end of said body member and being provided with a flange beyond said end, said plunger bore in said body member being further enlarged at said end to provide a spring receiving cavity, and said spring means comprising a spring mounted in said cavity around said sleeve and engaging said flange for moving said plunger away from said nozzle.

References Cited

UNITED STATES PATENTS

1,593,023	7/1926	Knudsen	239—533
1,952,816	3/1934	Mock.	
2,727,498	12/1955	Reiners	239—90
2,792,259	5/1957	Shallenberg	239—90
3,131,866	5/1964	Cummins et al.	239—584
3,146,949	9/1964	Reiners	239—584

FOREIGN PATENTS

767,717	5/1934	France.

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