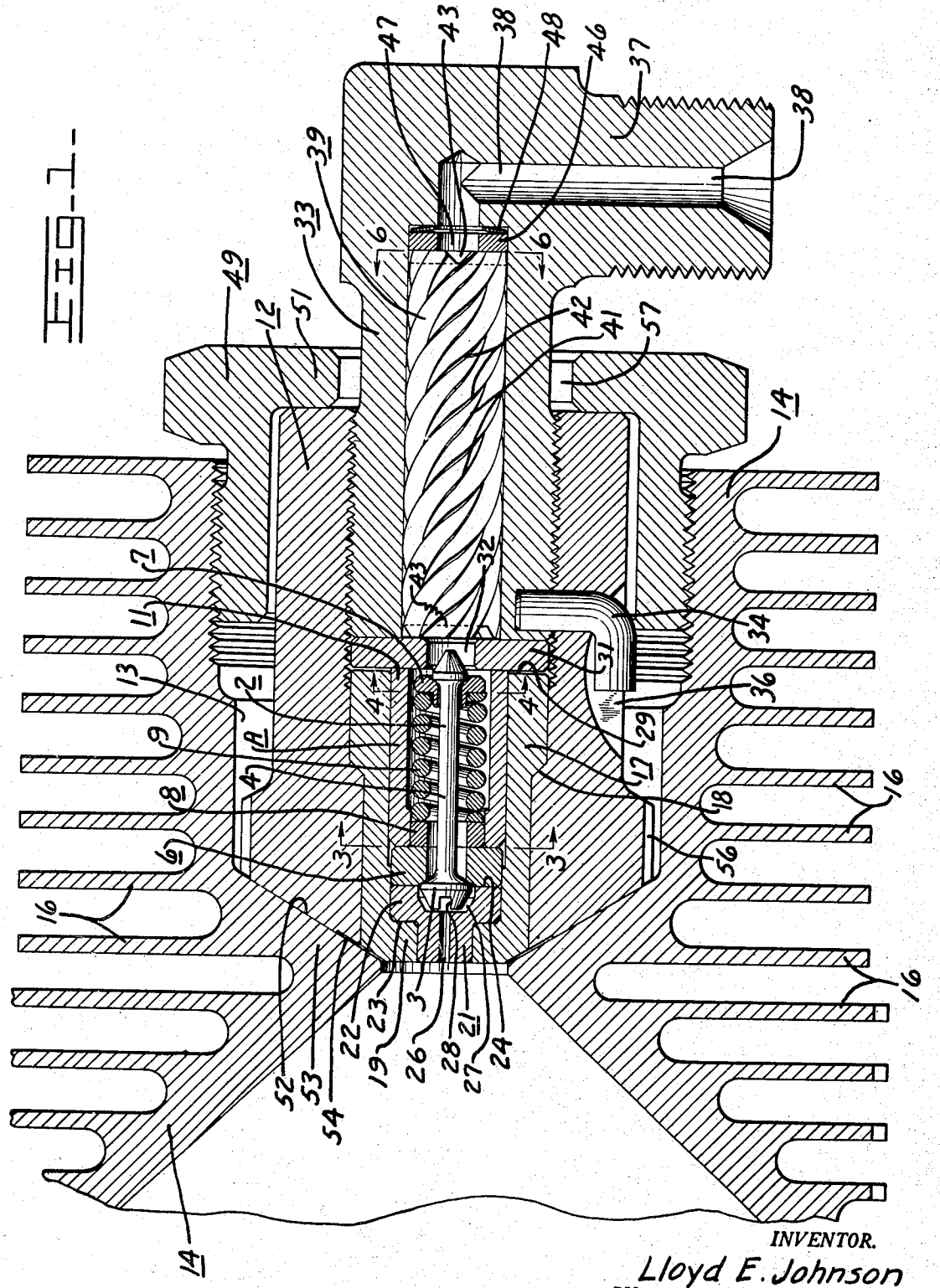
Nov. 12, 1946. L. E. JOHNSON 2,410,946

FUEL INJECTION MECHANISM

Filed April 10, 1943 4 Sheets-Sheet 1

FIG-1-



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FUEL INJECTION MECHANISM

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Fig. 2.

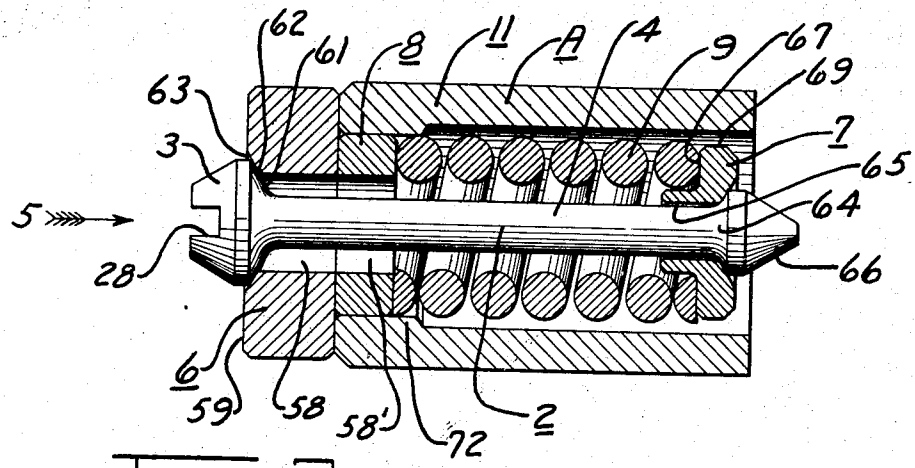


Fig. 3.

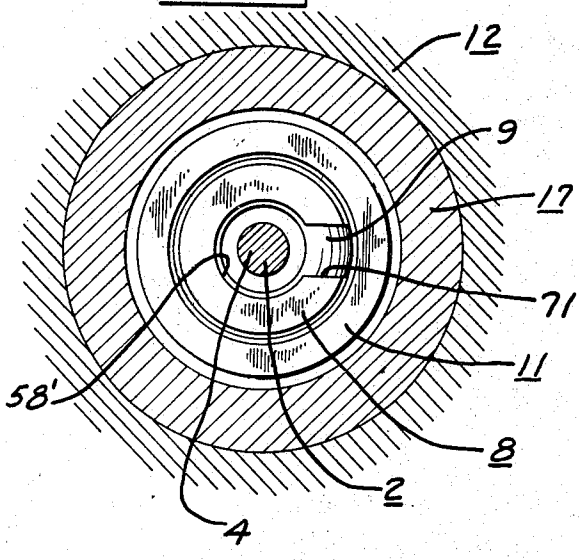


Fig. 4.

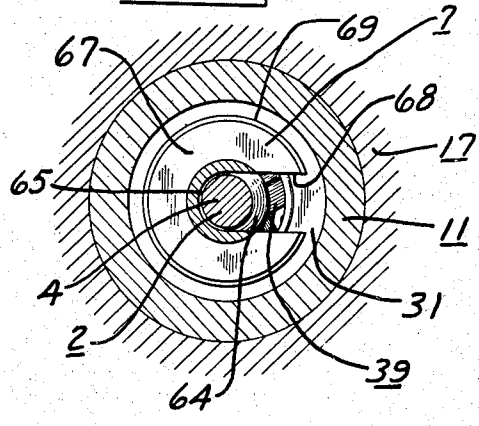


Fig. 5.

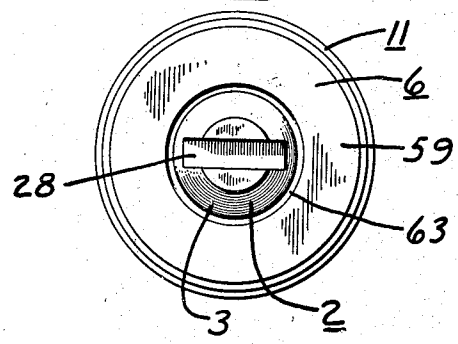
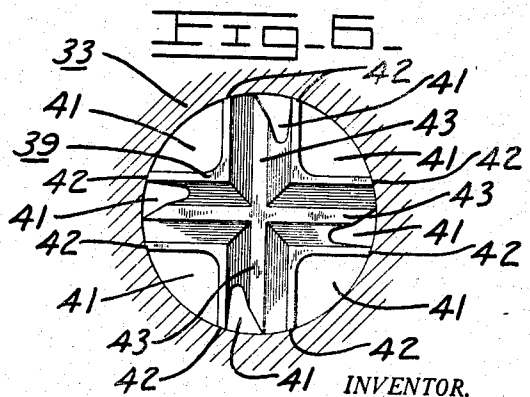


Fig. 6.



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FUEL INJECTION MECHANISM

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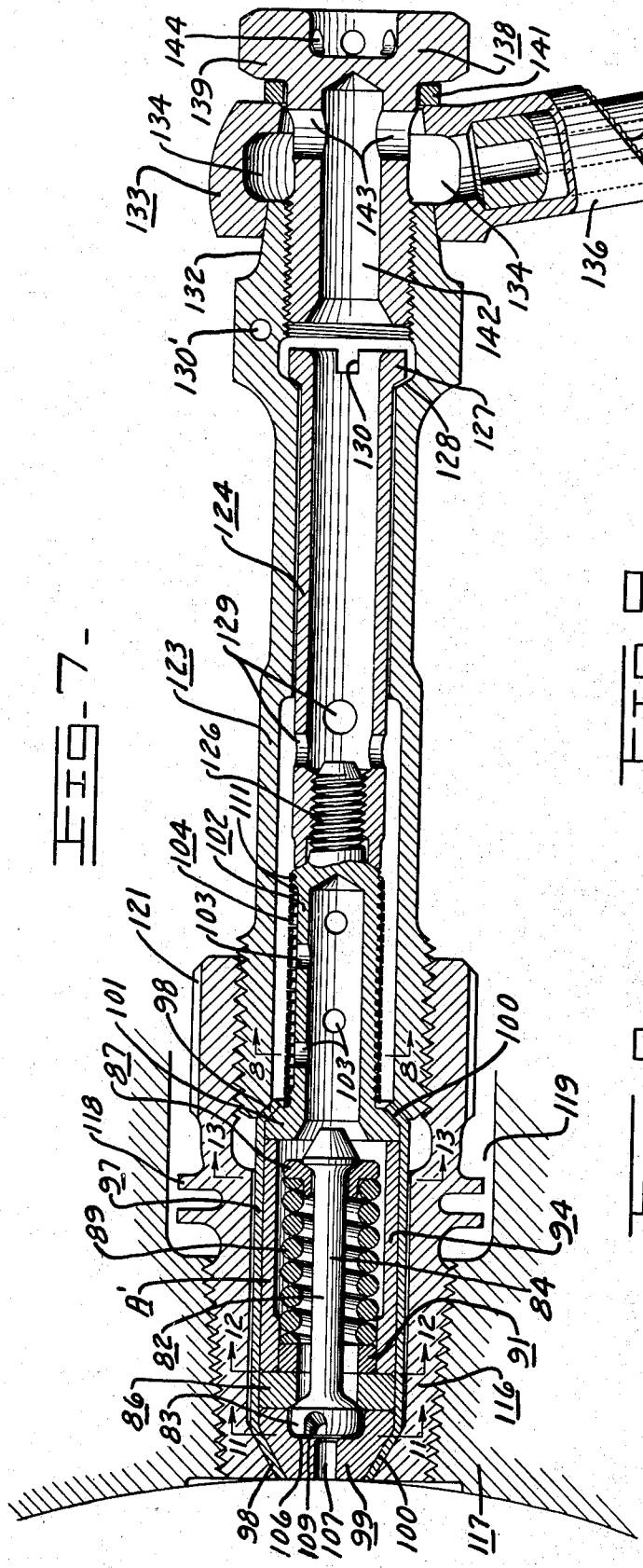


FIG-7-

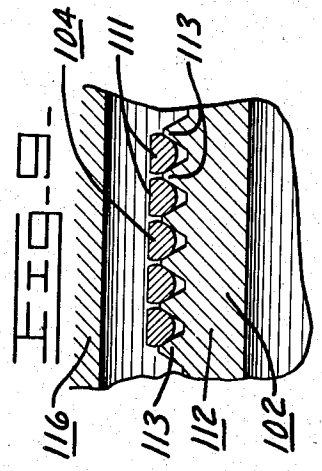


FIG-9-

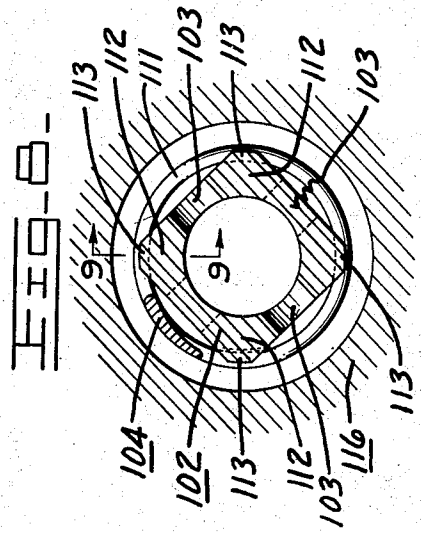


FIG-8-

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FUEL INJECTION MECHANISM

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FIG-10-

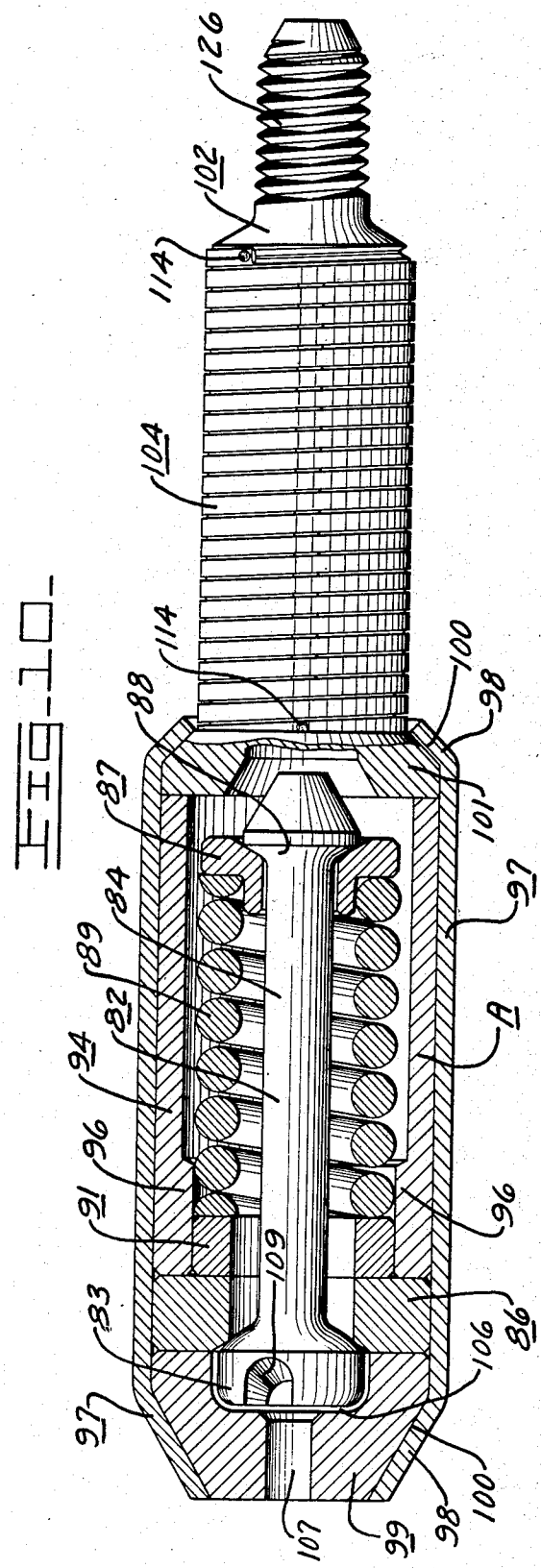


FIG-13-

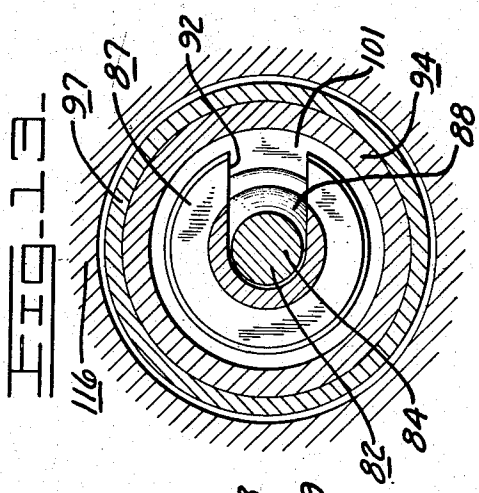


FIG-12-

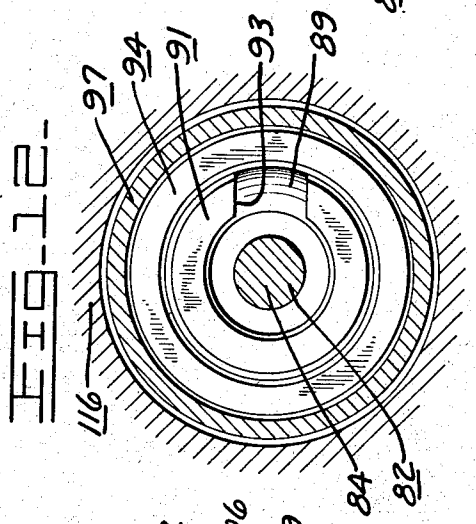
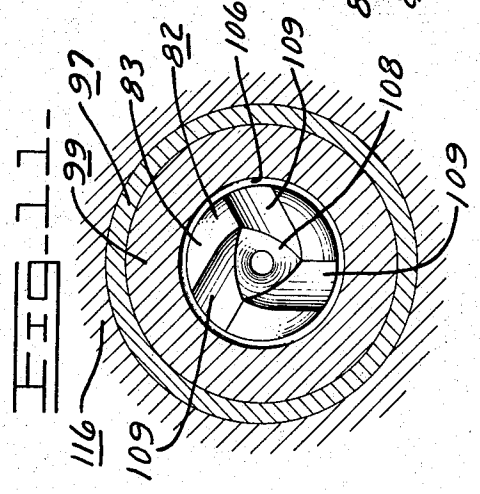


FIG-11-



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Patented Nov. 12, 1946

2,410,946

UNITED STATES PATENT OFFICE

2,410,946

FUEL INJECTION MECHANISM

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Application April 10, 1943, Serial No. 482,577

2 Claims. (Cl. 251—145)

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My invention relates to fuel injection mechanism, and more particularly to a fuel injection nozzle of the outwardly opening valve type adapted for delivering timed injections of liquid fuel, into an internal combustion engine.

Nozzles of this character may be employed either for the injection of a readily volatile fuel, such as gasoline, into an internal combustion engine of the spark-ignition type, or for the injection of relatively non-volatile fuel oil into a Diesel or compression ignition engine. Metering of fuel to the nozzle is generally accomplished by a fuel injection pump of any suitable type, which is adapted to pump a measured quantity of fuel for each injection stroke of the pump. The pressure of the fuel created by the pump causes opening of the nozzle valve to effect flow of fuel under pressure, into the engine.

For efficient engine operation, particularly in a multiple cylinder engine with each cylinder of which is associated a fuel injection nozzle, it is extremely desirable that the individual nozzles have a high frequency operation. In other words, the valve member in the nozzle should open in a minimum period of time for discharge of fuel, and also close with a popping action to shut off fuel discharge from the nozzle in a minimum time period, to insure good atomization of the fuel when the nozzle opens, and proper metering of the fuel at all engine speeds from idling to full load speeds. Such action is particularly desirable in high speed engines in order to provide for proper fuel injection timing.

In order to obtain the desired high frequency nozzle, it is desirable to employ a high rate spring in association with the nozzle valve member, or, in other words, a stiff spring which serves to close the nozzle valve member upon termination of fuel injection and against which the valve moves when it is opened by fuel pressure. Also, it is desirable that the weight of the spring and the mechanism operated by the spring be relatively light so as to minimize damping of the spring which might otherwise be caused by the inertia of relatively heavy parts, thereby allowing the spring to act fast in closing the valve.

My invention has as its objects, among others, the provision of an improved high frequency fuel injection nozzle of the outwardly opening valve type, designed to satisfy the above mentioned requirements, and which employs a stiff or high rate spring; is provided with a valve member having a floating mounting in the nozzle so that during movement thereof there can be no damping effect on the spring which might otherwise be

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caused by friction or rubbing parts; is of such character as to enable the proper degree of compression to be placed on the spring so that all like nozzles may have like metering characteristics; is provided with spring retainer means which cooperates in providing for proper compression on the spring, and which has a guideless mounting in the nozzle to preclude damping effect on the spring; is well shielded against the entrance of dirt and other deleterious matter which might adversely affect proper nozzle operation; is provided with means to enable accurate control of the extent of opening of the valve; and which is of relatively simple and economical construction. Other objects of my invention will become apparent from a perusal of the following description thereof.

Referring to the drawings:

Fig. 1 is a longitudinal sectional view of one form of nozzle mechanism of my invention, adapted for employment in a type of compression ignition or Diesel engine in which it is now being embodied; a portion of the precombustion chamber of such engine being also shown in section. The scale of Fig. 1 is drawn to approximately three times full size.

Fig. 2 is an enlarged longitudinal sectional view of a valve assembly unit forming part of the nozzle structure illustrated in Fig. 1.

Fig. 3 is an enlarged horizontal section taken in a plane indicated by line 3—3 in Fig. 1.

Fig. 4 is an enlarged horizontal section taken in a plane indicated by line 4—4 in Fig. 1.

Fig. 5 is an end view looking in the direction of arrow 5 in Fig. 2.

Fig. 6 is a fragmentary horizontal sectional elevation taken in a plane indicated by line 6—6 in Fig. 1.

Fig. 7 is a longitudinal sectional view of another form of nozzle mechanism adapted for employment in an engine wherein the valve may occupy less space, such as in the head of a spark ignition engine; a portion of the engine being also shown in section. The scale of Fig. 7 is drawn to approximately three times full size.

Fig. 8 is a horizontal section taken in a plane indicated by line 8—8 in Fig. 7.

Fig. 9 is a fragmentary section taken in a plane indicated by line 9—9 in Fig. 8.

Fig. 10 is an enlarged longitudinal sectional view of a valve assembly unit forming part of the nozzle structure illustrated in Fig. 7.

Fig. 11 is a horizontal section taken in a plane indicated by line 11—11 in Fig. 7.

Fig. 12 is a horizontal section taken in a plane indicated by line 12—12 in Fig. 7.

Fig. 13 is a horizontal section taken in a plane indicated by line 13—13 in Fig. 7.

In the embodiment of the invention illustrated in Figs. 1 through 6, the fuel injection mechanism comprises a valve assembly unit A which will be described hereinafter in greater detail and which includes outwardly opening valve member 2 having a valve head 3 at one end thereof integral with elongated stem 4, seat 6, spring retainer 7 associated with valve stem 4, spring abutment member 8, spring 9 compressed between retainer 7 and abutment member 8, and sleeve 11 about abutment member 8. As can be noted from Fig. 2, spring 9 holds all the parts of this assembly together with the exception of sleeve 11 which fits around abutment member 8. In the compression ignition engine in which such assembly is employed, there is sufficient space to provide a holder therefor of sufficient thickness of metal to transfer heat away from the nozzle; this being desirable in a compression ignition engine because of the relatively high maximum operating temperatures in such an engine.

The holder includes an outer sleeve member 12, within recess 13 in compression ignition engine part 14 having external cooling fins 16. Preferably, sleeve 12 is of a metal of relatively high heat conductivity, such as aluminum, for the purpose of conducting heat away rapidly from the nozzle tip. Press fitted within the outer sleeve 12 is an inner sleeve member 17 having conically surfaced external shoulder 18 which seats against a complementary tapered internal shoulder in outer sleeve 12. Valve assembly unit A is clamped in position within inner sleeve 17; and to provide for strength to withstand the clamping stress, sleeve 17 is preferably made of steel. At the fuel discharge end of the injection mechanism, inner sleeve 17 is formed with an internal shoulder 19 on which is seated nozzle tip member 21 having peripheral shoulder 22 provided with a flat seating face 23 resting on shoulder 19, and with an opposite flat seating face 24 against which rests one side of seat 6 of valve assembly unit A.

Tip 21 fits with a light press fit within the aperture defined by internal shoulder 19, so as to be readily insertable in and removable from inner sleeve 17, and has an axially extending elongated fuel discharge passage or orifice 26, for the purpose of effecting a penetrating spray which is desirable in the injection of fuel oil into a compression ignition engine. Passage 26 communicates with a recess 27 formed in tip 21 to accommodate head 3 of the valve which is normally sealed against one side of seat 6 by spring 9. Upon injection of fuel by the pressure created by the fuel injection pump (not shown), the valve will open to allow discharge of fuel; the extent of opening of the valve being determined by the depth of recess 27. Thus, tip 21 serves as a stop for determining the extent of outward opening of the valve. Preferably, the volume of recess 27 is at a minimum with reference to the volume occupied by head 3 to minimize the volume from which fuel might escape after injection, thus minimizing dribbling at the nozzle. In this connection, head 3 is provided with a cross slot 28 to allow flow of fuel into fuel discharge passage 26 when the valve opens.

In order to have the same fuel injection characteristics in all like fuel injection nozzles, it is desirable that the extent of opening of the valve be the same for all such like nozzles. In various

production valve assembly units A, valve heads 3 may not all be of exactly the same axial thickness which may result from the usual dimensional differences which occur in commercial production, or the heads 3 might not all seat exactly at the same location on seats 6. Therefore, if nozzle tips 21 were employed having recesses 27 all designed to have the same depth, the extent of opening of the valve might vary among different nozzles. To insure that such extent of opening will be the same for all nozzles, I provide nozzle tips 21 having recesses 27 of varying depths; and in assembling the nozzle, the proper nozzle tip is selected by testing to insure that the extent of opening of the valves will be the same in all assembled nozzles.

Means including the nozzle holder is provided for transmitting clamping pressure through sleeve 11 of valve assembly A to clamp together seat 6 and nozzle tip 21 in the holder. In this connection, it is to be noted that inner sleeve 17 of the holder is of less length than outer sleeve 12 of the holder, and that sleeve 11 of valve assembly A extends beyond end surface 29 of inner sleeve 17. A plate 31 having central aperture 32 is supported on the end of valve assembly sleeve 11 adjacent surface 29, and transmits clamping pressure to sleeve 11 to hold the previously mentioned parts together. Clamping pressure is imparted to plate 31 by sleeve 33 screwed in outer sleeve 12 of the holder; sleeve 33 and sleeve 12 being locked together by means of L-shaped locking pin 34, one leg of which fits through apertures in these parts, and the other leg of which lies in a recess 36 formed in the outer surface of sleeve 12. At its outer end, sleeve 33 is formed with a right-angle extension 37 having fuel flow passageway 38, and which is adapted for connection to the fuel line (not shown) leading to the fuel injection pump (not shown).

I preferably provide in sleeve 33 a fuel strainer 39 to remove any relatively coarse foreign particles that may be in the fuel. Any suitable strainer may be employed; the strainer illustrated comprising a cylindrically-shaped solid member having a plurality of axially extending spirally-shaped grooves 41 leading from one end of the member to the other, and which form complementary spirally-shaped fins 42, the edges of which fit with slight clearance with respect to the inside wall of sleeve 33. As can be observed from Fig. 6, each end of strainer 39 is formed with a pair of cross channels 43, the opposite ends of each of which communicate with sets of the grooves 41. However, the channels 43 at either end of the strainer communicate with different grooves than those at the opposite end. The end of the strainer adjacent valve assembly unit A engages plate 31 which overlaps the inside of sleeve 33, and consequently serves to seal off the grooves 41 at such end of the strainer, which do not communicate with cross channels 43 at that end.

The opposite end of the strainer engages plate 46 having an aperture 47 for flow of fuel therethrough from passage 38; plate 46 and strainer 39 being held in position by apertured spring 48 in the form of a bowed ring of sheet metal. As with respect to plate 31, plate 46 seals off the grooves 41 which do not communicate with cross channels 43 at the end of the strainer covered by plate 46. Thus, fuel entering the ends of grooves 41 at the inlet end of the strainer cannot escape from the same grooves at the discharge end of the strainer, but must flow over fins 42 which will strain out

foreign particles, and into the grooves which communicate with cross channels 43 at the strainer discharge end. The type of strainer described is quite efficient for the straining of relatively viscous fuel oil such as is encountered in compression ignition engines.

For clamping the nozzle on the engine, I provide an externally threaded nut 49 having shoulder 51 adapted to engage an end of outer sleeve 12, and which is adapted to be screwed into engine part 14 to apply pressure against sleeve 12 and clamp the opposite end of sleeve 12 against such engine part. The seating end of sleeve 12 is provided with a conically-shaped seating surface 52 adapted to engage a complementary conically-shaped surface on a shoulder 53 integral with engine part 14. Preferably, clearance space 54 is provided adjacent the discharge end of the nozzle to provide insulation at that point; and the portion of sleeve 12 adjacent the discharge end of the nozzle is provided with longitudinally extending splines 56 for the purpose of enabling the sleeve to be turned by a suitable tool for screwing on sleeve 33.

In assembling the nozzle, tip 21 and valve assembly unit A are first positioned in sleeve 17 which is press fitted in sleeve 12. Then, nut 49 may be placed over sleeve 12. Strainer 39 and its associated parts may then be positioned in sleeve 33 which is insertable through aperture 57 in nut 49; and upon screwing sleeve 33 in sleeve 12 against plate 31, the parts will all be held in position.

Valve assembly unit A of my invention forms an important part thereof. With reference to Fig. 2, it is to be noted that the entire valve member 2 has a floating mounting in the nozzle, as it is not piloted in any way. Stem 4 passes loosely or freely through an enlarged aperture 58 in seat 6, and through an enlarged aperture 58' in spring abutment spacer member 8. Also, retainer 7 is not guided or piloted in any way in sleeve 11. Thus, valve member 2 is centered during opening thereof solely by the fuel stream flowing through the nozzle; and as a result the peripheral orifice, which is formed when valve head 3 is moved away from the seating side 59 of seat 6 by fuel pressure, will always be of the same width around its entire periphery, thus insuring a uniform spray at all times. This might not otherwise be the case if the valve member 2 were guided or piloted in the nozzle because such arrangement might produce off-centering of valve head 3 when it opens by fuel pressure.

To insure proper seating of head 3 about its entire periphery, against seating side 59 of seat 6 when the nozzle is closed, seating surface 61 of head 3 is formed to have the shape of a segment of a sphere, and is adapted to engage along an edge 62 at an inner beveled part 63 in seating side 59. Thus, should there be slight misalinement of valve stem 4 in the closed position of the valve, head 3 will always be tightly sealed about its entire periphery. This is important in precluding dripping at the nozzle. In this connection, it is to be observed that the peripheral surface of head 3 throughout its entire path of movement during opening and closing of the nozzle, has relatively wide clearance in recess 27 of nozzle tip 21. Such guideless mounting of the head cooperates in permitting accurate seating thereof.

With particular reference to spring retainer 7, it is to be noted that it fits freely or loosely about stem 4, and is held against a bevelled

shoulder 64 on the stem by means of spring 9; a clearance space 65 being provided about stem 4 between the retainer and the stem. A conically shaped head 66 is formed adjacent shoulder 64 merely to enable gripping and centering of valve member 2 by a suitable tool during manufacture thereof. Abutment surface 67 on the retainer is made flat, and spring 9 is squared off at its ends to seat accurately against abutment surface 67, as well as abutment spacer 8. To enable positioning of the retainer about stem 4, it is provided with an inwardly extending slot 68 through which stem 4 may be inserted. The periphery 69 of the retainer is free of contact with sleeve 11, thus providing a guideless mounting therefor in the nozzle.

The guideless mounting of the valve not only allows automatic centering thereof by the fuel stream, as was previously explained, but also precludes damping effect on spring 9 which would be caused if the spring were to work against rubbing or frictionally engaging parts. Thus when the spring closes the valve after termination of fuel injection, it only has to move the weight of the valve and the retainer. This enhances fast closing of the valve with a popping action. Furthermore, opening of the valve by fuel pressure is also made faster by the elimination of rubbing parts.

With respect to prior outwardly opening nozzle constructions wherein a spring retainer is screwed on a valve stem, I have found that such arrangement is not desirable because a retainer nut screwed on the stem must be employed in association with other means for locking the nut. This creates extra weight, the inertia of which dampens the effect of the spring, thereby impeding fast action in opening and closing of the valve. Furthermore, it is relatively difficult with a retainer screwed on the stem to have it hold its exact position at all times; and slight change in the position thereof causes variation in the load imposed on the spring, which results in non-uniform spray characteristics among various nozzles on an engine. Since the retainer of my invention is held freely against shoulder 64, spring abutment surface 67 thereof will always be at a fixed position relative to valve stem 4.

Another important feature of the nozzle construction of my inventon lies in the provision of the removably mounted abutment or spacer member 8 which is held by spring 9 against the side of seat 6 opposite to that against which valve head 3 seats when the valve is closed. In assembly of the parts of valve assembly A, stem 4 is inserted through aperture 58 of seat 6 and through spring 9. Retainer 7 is then slipped over stem 4 and spring 9 is held against retainer abutment surface 67 by any suitable instrument. Abutment member 8, which is provided with an inwardly extending slot 71, is then slipped over stem 4 between seat 6 and the end of the spring 9 opposite that resting against retainer abutment surface 67. I provide abutment members 8 of various thicknesses; and by a suitable calibrating instrument, I measure the load on spring 9 resulting from the insertion of various abutment members 8. By selecting an abutment member of the proper thickness, the same predetermined load may be placed on spring 9 for all like nozzles assembled. Thus, such arrangement cooperates with the other features mentioned in insuring that all like nozzles will have uniform spray characteristics.

After assembly of the selected abutment mem-

ber 8, sleeve 11 is then slipped over the periphery of the abutment member to center it properly. Thus sleeve 11 not only serves to transmit clamping pressure to hold the nozzle assembly together in the manner previously described, but also serves as a retaining means for abutment member 8. In this connection, it is to be observed that the portion of sleeve 11 adjacent abutment member 8 is provided with increased thickness at 72 to center the end of spring 9 adjacent abutment member 8.

The embodiment of the invention illustrated in Figs. 7 through 13 is essentially the same as that previously described, insofar as the construction of valve assembly unit A' is concerned. Therefore, such unit will be described primarily with reference to the differences between it and the previously described valve assembly unit A. Unit A' comprises valve member 82 including valve head 83 and stem 84, seat 86, spring retainer 87 mounted freely about stem 84 and thrust against shoulder 88 on stem 84 by spring 89, and spring abutment spacer member 91 interposed between spring 89 and seat 86. Spring retainer 87 is provided with inwardly extending slot 92 to enable the retainer to be slipped over stem 84; and abutment member 91 is formed with a similar slot 93.

Abutment member 91 is of predetermined thickness to place a predetermined load on spring 89; and the parts are assembled in the same way as in the previously described embodiment of the invention, a sleeve 94 being provided about abutment member 91 to maintain the abutment member centered. In this connection, sleeve 94 is also provided with a portion of increased thickness 96 adjacent abutment 91 to serve as a centering means for spring 89.

As can be seen most clearly from Fig. 10, the valve assembly unit A' is contained in a holder 97 which is in the form of relatively soft ductile seamless metal tubing having its opposite ends 98 pressed or rolled over nozzle tip member 99 and a plate member 101, respectively. The peripheries of both nozzle tip member 99 and plate member 101 are formed with tapered surfaces 100; and when the ends of holder 97 are engaged over these end parts, the entire assembly will form a compact unit in which holder 97 serves as a tubular capsule providing a sealing envelope for the parts contained therein. Furthermore, nozzle tip 99, seat 86, sleeve 94, and plate 101 will be rigidly clamped together by clamping pressure transmitted through sleeve 94. In this connection plate 101, although it may be a separate member if so desired, is formed as an integral flange on strainer tube 102 which has apertures 103 to allow flow of fuel into the interior thereof, and a strainer 104 about the outside thereof which will be more fully described hereinafter.

The head of the nozzle valve of Figs. 7 through 13 is designed for injection of volatile fuels, such as gasoline, into a spark ignition engine. In such engine, it is desirable that the fuel spray be more diffused than fuel oil injected into a Diesel engine. For this purpose, valve head 83 which is contained in recess 106 in nozzle tip memebr 99, is so formed as to impart a swirling motion to the fuel for passage through discharge orifice or passage 107 in nozzle tip 99. With reference to Fig. 11, it will be noted that the side of head 83 adjacent orifice 107 is formed with a centrally disposed recess 108 in line with orifice 107, and with a plurality of inwardly extending passages 109 leading from the periphery of the head to recess 108; the axes of such passages being arranged tangentially with reference to the center of recess 108. Thus, when the valve is opened by pressure of fuel, a swirling motion will be imparted to the fuel. In this connection, it will be noted that orifice 107 is shorter and of larger diameter than orifice 26 in the previously described nozzle, so as not to impede the swirling effect imparted to the fuel.

As with respect to the nozzle of Figs. 1 through 6, the depth of recess 106 in nozzle tip 99 controls the extent of opening of the valve. To insure that the valve will open to the same extent for all like nozzles manufactured in production, tips 99 are provided with recesses 106 of predetermined depth; and by selecting a tip having a proper depth recess, during assembly of a nozzle, the extent of opening of the valve may be made uniform for all nozzles as in the previously described modification.

Although any suitable strainer may be employed about tube 102; in the embodiment of the invention illustrated, I preferably employ as the strainer a spring coil 111 in which the individual coils are relatively close together so as to strain out foreign particles that may be in the fuel. Tube 102, as can be seen from Fig. 8 is non-circular in cross section, and its corners 112 are formed with screw threads 113 in which coil 111 is screwed; coil 111 being spot welded to tube 102 at suitable points 114 to hold the coil fixedly in position. Preferably, the outer peripheral surface of the coil is ground flat as shown in Fig. 9, so as to eliminate any wide spaces between the interstices of the coil in which relatively wide particles might become caught, and thus clog the strainer.

The construction thus far described provides a complete unit, as shown in Fig. 10, which may be mounted in the engine. If the strainer described is not employed, the unit will be the same as that illustrated in Fig. 10 with an ordinary plate substituted for flange 101.

Fig. 7 illustrates a form of mounting means for the nozzle in an engine. Such mounting means will of course vary with various engines, depending upon space and size limitations. The mounting means illustrated comprises an adapter sleeve 116 screwed in head 117 of the engine, and having intermediate cooling fins 118 located in space 119 in the engine head. Splines 121 are formed on adapter 116 to enable a suitable tool to be engaged therewith for screwing of adapter 116 into head 117. Internal threads are provided in adapter 116 at the end opposite to that screwed in the engine head, into which an elongated clamping sleeve 123 may be screwed for clamping the nozzle in position. The tapered end parts 100 of the nozzle enable proper centering thereof when clamped in position.

To facilitate removal of the nozzle when sleeve 123 is unscrewed, I provide a sleeve 124 within clamping sleeve 123 and which has one end screwed onto a boss 126 integral with strainer tube 102, and the opposite end provided with a flange 127 adapted to engage an internal shoulder 128 formed in sleeve 123; the sleeve 124 being formed with apertures 129 to allow fuel which flows therethrough, to flow into sleeve 123 and through apertures 103 in strainer tube 102, to the nozzle. Since flange 127 is engageable with shoulder 128, it will be apparent that upon unscrewing of clamping sleeve 123, the entire nozzle assembly will be removed from the engine when sleeve 123 is lifted off the engine. A notch 130

is formed in flange 127 of sleeve 124 to enable insertion of a suitable tool for screwing such sleeve relative to boss 126 of strainer tube 102. To prevent turning of sleeve 123 when the nozzle is clamped in position, an aperture 130' is provided therein for insertion of locking wire that may be wound about a suitable part of the engine.

A special fitting is provided for connection of fuel line 131 to the described nozzle mounting means, which enables proper connection of the fuel line irrespective of the angular position thereof with respect to the nozzle axis. With reference to Fig. 7, it is to be observed that the end of sleeve 123 opposite to the nozzle end, is provided with an inward taper 132 over which complementary tapered ring 133 is adapted to fit; ring 133 being formed with an internal annular fuel passage 134, and being provided with tubular part 136 into which fuel line 131 is rigidly connected and sealed by suitable welding 137. Ring 133 is clamped in position by a cap screw 138 screwed into clamping sleeve 123, and having a head 139 between which and ring 133 is interposed sealing gasket 141. Cap screw 138 is provided with internal passage 142 communicating with apertures 143 in the wall thereof, to permit flow of fuel from passage 134 in ring 133. Apertures 144 in head 139 of the cap screw permit insertion of locking wire which may be wound about part 136 to hold cap screw 138 against turning.

From the preceding, it is seen that irrespective of the angular position of fuel line 131, it may be readily connected by the described connection, to sleeve 123, and that because of the tapered fit at 132 between the end of the sleeve and ring 133, the connection will be tightly maintained irrespective of engine vibration. It is to be noted that the tapered fit 132 is only at the end of sleeve 123 and the part of ring 133 adjacent such end, and not with the entire ring. As a result, fuel line 131 does not have to be bent

to any considerable extent when it is desired to connect it with or disconnect it from sleeve 123.

I claim:

1. A fuel injection nozzle comprising an apertured valve seat, an apertured spring abutment member adjacent the seat, a valve stem passing with clearance through the seat and abutment members and having a head on one end engageable with the seat, a spring retainer loosely connected with the opposite end of the valve stem, a spring interposed between said retainer and said abutment member to urge the valve head toward the seat, and a separate sleeve member embracing the abutment member and a portion of the spring to center them relative to the seat but free of contact with the retainer member and the greater portion of the spring whereby the valve stem is unguided with relation to the seat.

2. A fuel injection nozzle comprising a seat having an aperture therein, a valve member having a head adjacent one side of the seat and a stem extending through the aperture, the stem having a guideless mounting in the nozzle, a shoulder on the stem, an abutment member removably positioned at the opposite side of the seat and through which the stem extends with clearance, spring retainer means about the stem adjacent the shoulder and having a guideless mounting in the nozzle and a free mounting relative to the stem and moveably engaged with the shoulder, spring means about the stem between the abutment member and the retainer means, and a sleeve about the abutment member and the spring means engaging the periphery of the abutment member for retaining the abutment member in position, the sleeve being separable from the seat and having a portion adjacent the abutment member for centering the spring means and the remainder of the sleeve being free of engagement with the spring means.

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