

Aug. 17, 1937.

F. RITZ

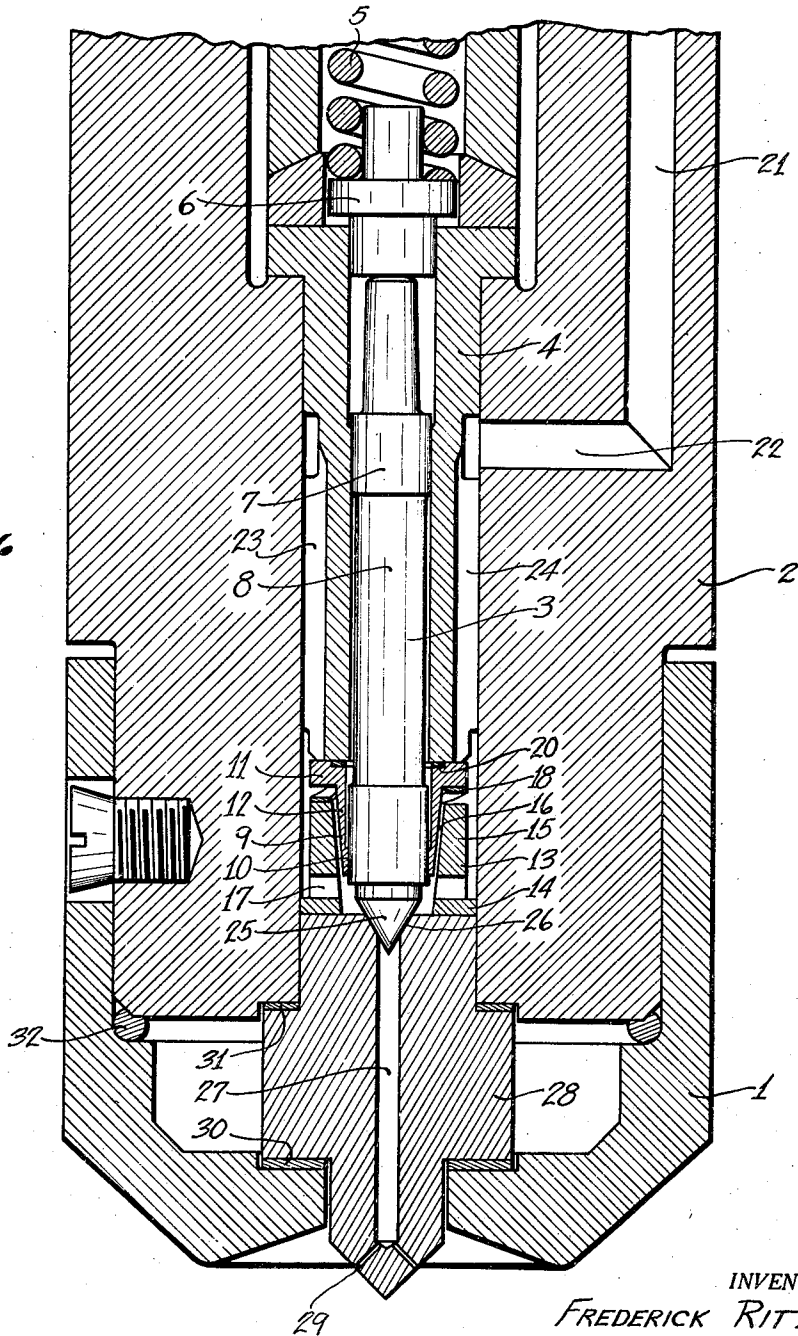
2,090,232

INJECTION NOZZLE

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2 Sheets-Sheet 1

*Fig. 1.*



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2 Sheets-Sheet 2

*Fig. 2.*

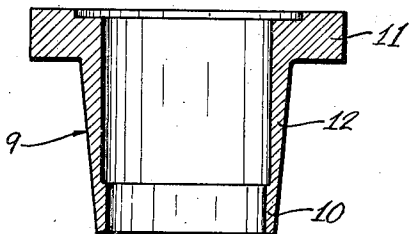


*Fig. 4.*

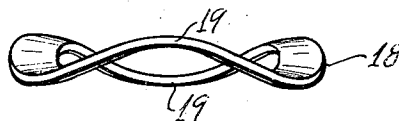


*Fig. 3.*

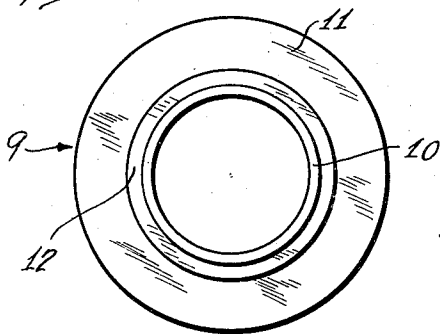


*Fig. 5.*

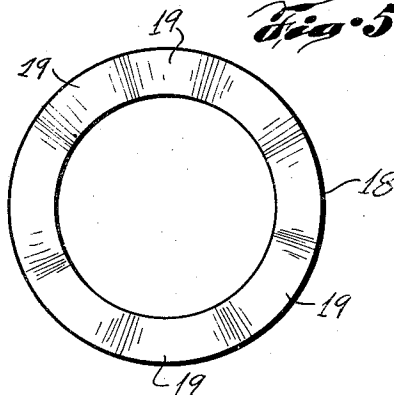


*Fig. 6.*

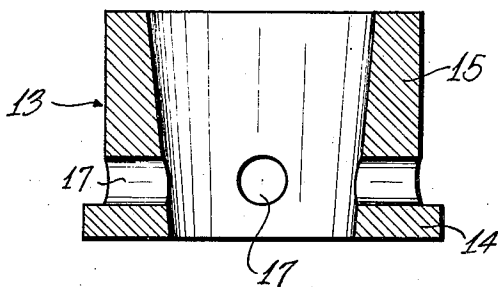
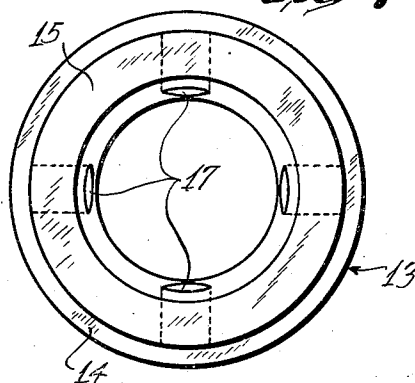


*Fig. 7.*



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## UNITED STATES PATENT OFFICE

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## INJECTION NOZZLE

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14 Claims. (Cl. 239—107.6)

This invention relates to improvements in injection nozzles, and more particularly to improvements in the needle valve construction in nozzles for high speed Diesel engines of solid-injection type.

In older prevailing injection nozzles the needle is fitted, in the sleeve in which it operates, by lap grinding, over a length of the needle many times its diameter. With this construction very little difficulty is experienced with sticking of the needle valve, so long as the engine operates on fuel oils of the usual specifications, and which are reasonably free of solids and objectionable foreign matter. However when unrefined crude oils are used, difficulties are continually experienced with sticking of the needle due to the presence of gums, paraffins, resins and solids, as well as the products resulting from oil decomposition caused by the heat and pressure during engine operation. These troubles are particularly encountered in the high speed solid injection type Diesel engine, and are highly objectionable since resulting in erratic engine performance and some expense for servicing and incident shutdowns.

In older prevailing nozzle assemblies the needle motion during operation did not eradicate the causes of the sticking, but sticking persisted until the nozzle was dismantled and thoroughly cleaned. If carelessly or hurriedly assembled, oil leakage would occur when the needle was in its closed position, or the sticking would persist, thus interfering with the engine performance and the regulation and amount of fuel being injected into the cylinders. This is objectionable because of the necessity of shutting down completely upon the needle sticking, as well as the uncertainty of good engine performance, when operation is resumed.

In older prevailing forms of nozzles much care and time was given to the lap grinding of the needle in the needle sleeve so as to insure the proper fit and concentricity of these parts. Such grinding over the entire lapped length is given small tolerance variation and has always been heretofore regarded as essential to maintain concentricity of the needle ends with respect to the sleeve. This practice is objectionable because of the great expense thus involved in manufacture, and because with such arrangement, poor needle action occurs when concentricity is impaired, due to the uneven wear between the needle and the sleeve surfaces.

In older forms of nozzles the seal at the lower needle end was obtained by providing sufficient

clearance for an operative fit between the needle valve and sleeve surfaces. This clearance is not affected by the pressure of the fuel oil, and is fixed at the time of machining or of assembling the nozzle. The pressure of the fuel oil around the needle at the spray end does not aid in sealing, but rather tends to break the existing seal, thus causing oil leakage by the lap seal with the resultant formation of sludge particles on the needle or sleeve surfaces forming the seal. When this clearance between the sleeve and the needle increases due to the wear due to the operation of the needle, the seal is broken and replacement of parts is made necessary, because after assembly is completed there is nothing inherent in the construction of the nozzle assuring perpetuation of such seal. This is objectionable because only a minimum of wear can be obtained from such parts, before they must be discarded, and a complete refitting of the needle assembly required. This exceedingly high cost of manufacture of such parts is accordingly not reflected in the expected period of trouble-free service.

In older prevailing forms of nozzles the central portion of the needle, as well as the needle ends, was lap ground. This grinding has heretofore been thought necessary to insure the proper sealing and seating of the valve needle, and to assure concentricity along the entire needle length. This concentricity has now been found unnecessary to keep the needle properly seated, and the extensive lap grinding is objectionable because the oil formations causing the needle to stick, have thus a wider area over which to form.

It has been found from experience that in order to obtain a positive and effective needle action, the needle must be free from binding at all times and over its full length, and the needle valve must be fully seated to give the desired operating conditions. A poorly seated needle valve precludes the engine performance to be derived from the predetermined and regulated fuel quantities to be injected into the engine cylinder. It is, therefore, one of the objects of the present invention to provide an improved lap-seal which will attain the above noted advantages and combine the freedom from sticking with the freedom from maintenance and fussy attention that is usual with the metal or metal lapped seal substantially coextensive with the length of the needle element.

A further object is to provide, by means of a lapped section of reduced extent, and through improved packing facilities for the needle, a lap

seal which will prevent the leakage of fuel and resulting sticking of the needle, and which will serve mechanically to remove from the needle, any deposits of solids thereon, while the engine is in operation.

A further object is so to construct a gland element as to be acted upon and pressed against the needle valve, by the pressure of the fuel oil in the region of this gland. In the present embodiment the needle is lapped to a gland as thin walled as is practically feasible, to exaggerate distortion due to fuel pressure, to the point where the fuel pressure causes a substantial annular compression hug on the needle. Annular compressibility is sufficient to cause it to hug the needle snugly during injection periods when subjected to the usual fuel pressures. The compression hug of the gland on the needle, under the high fuel pressure external to the gland, prevents gums and tar from working into the zone of the lap.

A further object of the invention is attained in a minimization of the length of the lapped fit between the needle and sleeve, this object being preferably attained by confining the lap fitted zones to the extremities of the needle, and forming an intermediate portion thereof, of reduced diameter.

A still further object of the invention is attained by avoiding the necessity of precise concentricity of the needle element and the barrel or sleeve members in which it operates. In the example illustrated as a selected embodiment, this result is objectively attained by a suitable structure and arrangement of spring-pressed gland elements, at least one of which is floatingly positioned in such manner that, even though the lapped portions of the needle element and the lapped portion of the gland element may assume for any reason, a somewhat eccentric position relative to each other, the seal between the needle and the gland element is always preserved.

A still further object is to provide a lap-seal the length of which is only a fractional part of the needle diameter, rather than several times the plunger or needle diameter. This extremely short lap so reduces the total shear strength of any adhering solids which may form in the lap zone, relatively to the fuel pressure opening force and the spring closing force, that the film is easily sheared and the needle kept moving despite the presence in or formation of resinous or other solid matter from the fuel.

Further objects and advantages will appear from the following detailed description of parts and from the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of a preferred form of injection nozzle, to which the present improvements are applied; Figs. 2 and 3, are, respectively, an enlarged vertical section and a plan view showing in detail the construction of the inner, externally-tapered gland; Fig. 4 is a side elevation and Fig. 5 a plan view of an annular plate spring utilized with the gland elements, and Figs. 6 and 7 are respectively, an enlarged vertical section and a plan view showing in detail the construction of the outer internally tapered gland.

Referring to the drawings by characters of reference, numeral 1 designates a lower cap element of the injector body, and 2 the cylinder body or barrel of the nozzle assembly. A needle valve 3 is operatively disposed in a sleeve 4, and is normally releasably held in closed position by a compression spring 5, which rests upon the needle

extension piece 6. In order approximately to center the needle in the sleeve, there is provided an upper lapped fit between these elements. This upper lap 7, on needle 3, is about equal in length to the needle diameter in the lapped zone, and is lap ground to the needle sleeve 4 over such zone. The needle 3 is characterized by a reduced central portion 8, and the opposite end of the needle is guidingly positioned by a gland element 9. This tapered gland 9 is by preference, first lapped to the needle 3 over the entire gland length, and is then counter ground to leave only about one-third of the needle diameter as the lap-length of the sealing zone 10.

The tapered gland element 9 consists of two portions, viz., a positioning-flange portion 11, projecting downwardly from which is a portion of tapered annular section 12 which terminates downwardly in a wiper or scraper edge at the lower margin of the piece as it appears in Fig. 1. Surrounding a part of the gland element 9 is a lower gland element 13 consisting of a positioning or base flange 14, and a tapered projecting portion 15. The portion 15, although of a somewhat heavier section, is tapered to correspond approximately in slope to that of the portion 12 on the gland member 9. A difference is to be noted between the two members in that the base flange 14 of the gland 13 is substantially of even diameter with the bore of the housing or barrel, so that the lower gland element is laterally fixed in position in the injector. By reason of the diameters and the corresponding taper of the two partly telescopic gland elements, a spacing of uniform width, indicated at 16, exists between the telescoped portions of the glands. This permits a uniform access of the oil to the space about the tapered portion of the gland 9 for the purpose of constricting the same about the lapped zone at the inner end of the needle. To insure freedom of access of the oil to this high pressure zone, there are provided a plurality, shown as four, of radial channels 17 (Figs. 1 and 7), which also serve as avenues of entrance for the fuel delivered to the injector, particularly to the valve and valve seat.

As will appear from Fig. 1, the lower gland element 13 serves as a lower abutment for a spring 18, bearing upon the upper surface of which is the flange portion 11 of the gland 9. The spring 18 is of annular form in plan, but is characterized by a plurality of angulate, or alternately concave and convex portions 19, (Fig. 4), each in the nature of a bow spring and the arms of which are alternately, oppositely deflected from the median plane of the spring; although six such oppositely deflected arm portions characterize the spring shown, obviously any number thereof may be utilized. The spring 18 serves the purpose in assembly and operation, of floatingly positioning the upper gland member 9 in displaceable abutment against the inner horizontal end surface of the barrel 4 in which the needle operates. For the purpose of providing a seal at this point, there is provided a gasket 20, preferably recessed in the upper surface of the flange 11 of the gland 9.

As well understood in the art, fuel oil is supplied under pressure to an injector such as that presently described, by means of an injection pump (not shown) connected by suitable tubing (not shown), communicating with an inlet passage 21 consisting of a vertical bore within the body 2. The passage 21 supplies in turn a short horizontal passage 22, directed into the central bore of the body 2, the barrel or sleeve 4 being provided with longitudinal ribs or fins 23 serving

to keep the barrel centered within the body 2, the space between these ribs constituting passages 24, continuing the passage 22. Obviously, there may be, and preferably are, a number of the passages 24, all arranged to deliver fuel to the space about the lower gland 13 and through the radial channels 17 to the valve. According to preference, the valve is characterized by a conical valve end or element 25 seated in an accurately machined counterbored portion 26 directed to a vertical discharge channel 27. The discharge channel is formed in a separate nozzle-forming structure 28, provided at its inner ends with nozzle openings 29 directed into the combustion space.

In assembly of the device, the lower cap element serves to position the nozzle-forming member, and a fluid tight joint is formed therewith by a suitable gasket 30, and a companion oppositely disposed gasket 31. A somewhat larger ring gasket 32 may be employed to seal the joint between the cap 1 and the barrel or body 2.

From the arrangement of the gland elements as described, it will appear that the upper gland element is so mounted as to be susceptible of a certain limited axial movement with respect to the needle element, as the needle is reciprocated responsively to the peak fuel pressures. Furthermore, this gland is susceptible of a slight limited lateral movement within the barrel, due to the fact that the flange portion 11 is of somewhat less diameter than that of the barrel portion in which the gland is located. It thus appears that, irrespective of exact concentricity of the needle, barrel and sleeve, there will nevertheless be maintained at all times a reliable fluid seal at the inner end of the needle and adjacent the valve proper.

In operation of the assembly illustrated, the fuel enters the inlet, thence through the bore 21 and into conduit 22 and passages 24, which are formed by and between the ribs 23 maintaining the needle sleeve in a rigid, fixed position. From these passages 24, the fuel enters the chamber or space 16 whence, upon lifting the needle valve by the fuel oil pressure, it enters the passage 27, from where it is forced through the orifices 29 into the engine cylinder. The needle valve is normally held in closed position by the compression spring 5, the loading of which depends upon the predetermined fuel injection pressure. The valve remains closed until the fuel pressure exceeds the spring pressure, and remains open until the spring pressure exceeds the fuel oil pressure.

The fuel in chamber 16 is under pressure and free to travel between the opposed mating surfaces of the tapered glands. Because of the thin metal construction and uniformly exposed surface area of the inner externally tapered gland 9, the lapped portion of part 12 is compressed, constricted or shrunk on to the needle under the action of the high external fuel pressure. This compression hug prevents gums, tar and any solids from working into the zone of the lap. The short lap so reduces the total shear-strength of any film of tar, carbon, resin or the like which might form in the lap zone, that the film is easily sheared and the needle kept moving despite the presence or formation of solid or semi-solid foreign matters.

In the foregoing description, for convenience, the axially opposed portions of the several elements have frequently been described as upper and lower portions, thus implying a necessarily vertical location of the assembly as it appears in Fig. 1. It is however to be understood that the

terms "upper" and "lower" are not to be construed as limiting the position of operative placement of the device or any part thereof, since obviously the injector may be employed in any angular position relative to the horizontal or to the cylinder axis.

It will of course be understood that the present detailed description of parts and construction as shown in the accompanying drawings refer only to a preferred embodiment of the invention, and that substantial alterations and modifications may be made without departing from the intent and scope of this invention as defined by the claims:

I claim:

1. In a high pressure fluid valve assembly for the solid injection of liquid fuel, a valve, a valve stem and a seat for the valve, a packing element embracing the valve stem, said element having a portion extending along the stem through a zone subjected to the pressure of fluid controlled by the valve, said portion being of a cross sectional area sufficiently reduced to be constricted about the valve stem, under the influence of the fluid pressure external thereto, in said zone, and the packing element being of a length, axially of the valve stem, substantially greater than the axial length of said zone.

2. In a valve for the solid injection of liquid engine fuels, an elongate valve member, a housing structure in which said member operates, means forming a seating surface for said member, there being in the housing a zone characterized by a periodically high pressure, a gland member formed to contract about the valve element, and externally subjected to the high fluid pressure in said zone, and means supporting the gland member to permit movement thereof both longitudinally of and laterally, within the housing structure.

3. In an injector for the solid injection of liquid engine fuel, a reciprocable valve actuating member, a gland element surrounding a portion of said member, and including an annular portion externally exposed to fluid pressure within the injector and operable by contraction responsively to such pressure to embrace, in fluid sealing relation, the adjacent portion of the valve actuating member, and spring means through which the gland element is enabled to maintain a coaxial relation to the actuating member.

4. In an injector for the solid injection of liquid engine fuel, an injector housing, a reciprocable valve actuating member, a guide sleeve embracing one portion, a gland element embracing another portion of the reciprocable member, and externally subjected to the fluid pressure within the injector, the gland element being supported within the injector housing, and a spring disposed so as yieldably to position the gland element with respect to the guide sleeve.

5. A guide and gland assembly for the needle member of an oil injector of solid injection type, the assembly including a guide for the needle member, and a pair of gland elements, each including an external supporting flange portion and a tubular extension therefrom, said elements being disposed partly in telescopic but spaced relation, and a spring between and tending relatively to position said elements, but disposed to permit movement of one thereof axially with respect to the needle member and the guide.

6. In an injector for the solid injection of liquid engine fuels, a continuous elastic collar externally subjected to the fuel pressure, a valve stem struc-

- ture operating through said collar, a guide for the stem structure, spaced from the collar, the collar being of reduced cross sectional area and so adapted to be shrunk upon the valve stem structure under the influence of fuel pressure in the injector, and a spring disposed for yieldably biasing the collar axially of the stem structure and toward the guide.
7. In an injector for liquid engine fuel, including a valve and valve stem structure, a guide member for the stem structure, a packing gland element embracing a portion of the stem structure beyond the guide member, and characterized by a flexibly supported, inwardly projected collar of reduced sectional area, adapted as a scraper element for the removal of accumulated foreign matter from the stem structure.
8. In an injector for liquid engine fuels, a needle valve element, a guide therefor, a spring tending to seat the valve element, a gland structure characterized by a thin annular contractible portion externally subjected to fluid pressure and floatingly supported about the needle valve member, and resilient means for yieldably positioning the gland structure.
9. In an injector for liquid engine fuel, a needle valve member, a fixed guide therefor, and a combined packing and wiper member characterized by a thin annular portion embracing the needle valve member, and means external to the wiper member, supporting the member to permit movement of the wiper member both axially and transversely of the guide, and axially with respect to the needle valve member.
10. In an injector for solid injection of engine fuels, a valve, a valve stem structure, a guide in which the stem structure operates, the stem and guide being lap-ground over a zone substantially less in length than the coincident length of said members as related at rest, and a gland separate from, and displaceable with respect to the guide, by action of the stem structure, the stem and gland being lap-ground over a zone not materially greater in length than the first said zone.
11. In an injector for the solid injection of liquid engine fuels, a valve and valve stem structure, a fixed guide in which said structure operates, a gland displaceable axially of the stem, and also displaceable with respect to the guide, the stem structure being characterized by two spaced lap ground portions, coacting respectively with the guide and the gland, and a portion intermediate thereof of substantially greater length than said lap ground portions.
12. In an injector for liquid engine fuels, a valve and valve stem structure, a fixed sleeve in which the stem structure operates, the stem structure being characterized by spaced lap ground portions, one of said portions being lap fitted to the sleeve, and a gland member so proportioned as to be laterally shiftable relative to said sleeve, and having an annular portion lap fitted to the other said lap ground portion of the stem structure.
13. A packing gland for a fuel injector needle, including an external projection extending outwardly of the gland member in a direction transverse to the needle axis and forming a slot for a spring through which the gland member is adapted to be positioned, and a tubular extension to said flange, tapered in section in a direction away from the flange and terminating in a thin edge portion lap ground to the needle valve element, over a length thereof substantially less than the diameter of the gland-engaging portion of said element.
14. In an injector for liquid fuels, a needle valve member, a sleeve in which said member is operatively disposed and through which the needle valve member projects, a packing member having a portion of annular section embracing the projecting part of the needle valve structure and arranged for a limited axial movement therewith, and a spring tending to position the packing member in sealing abutment with said sleeve.

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