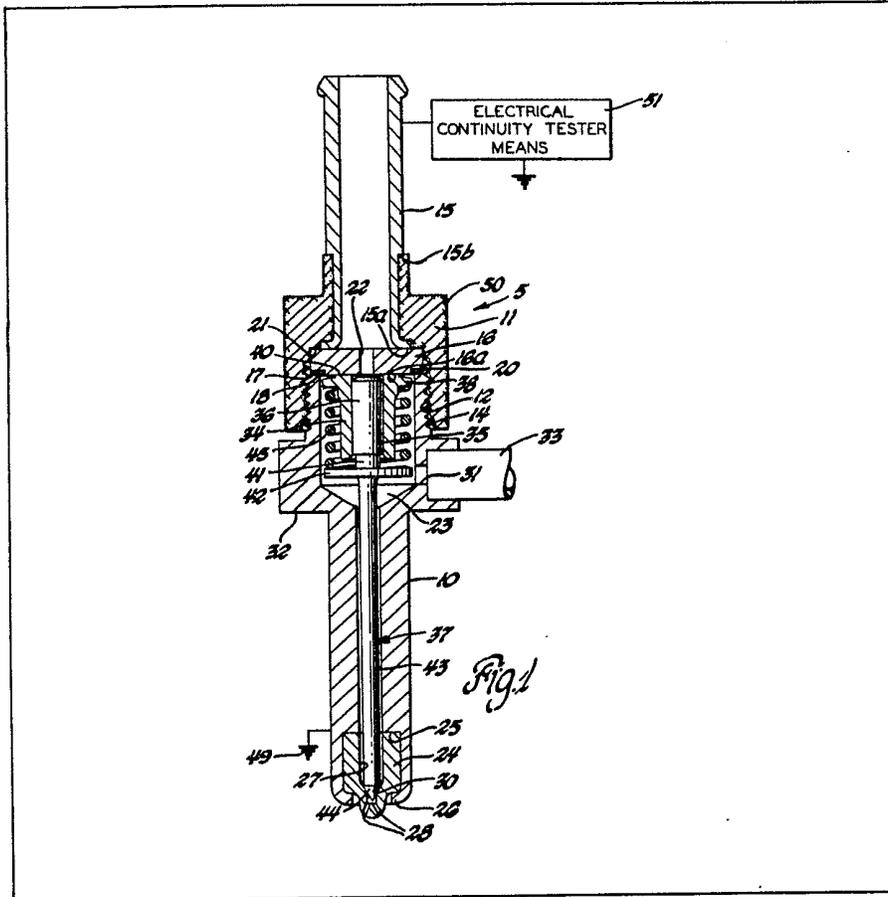


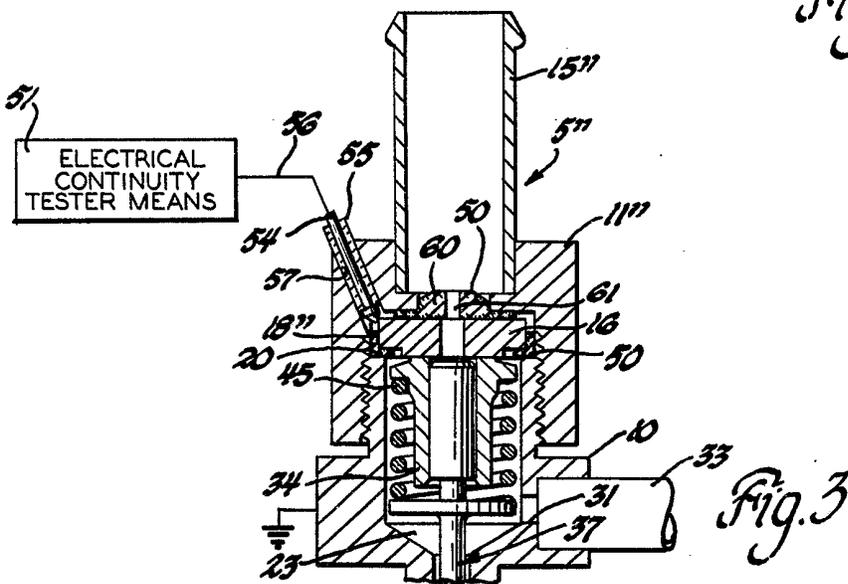
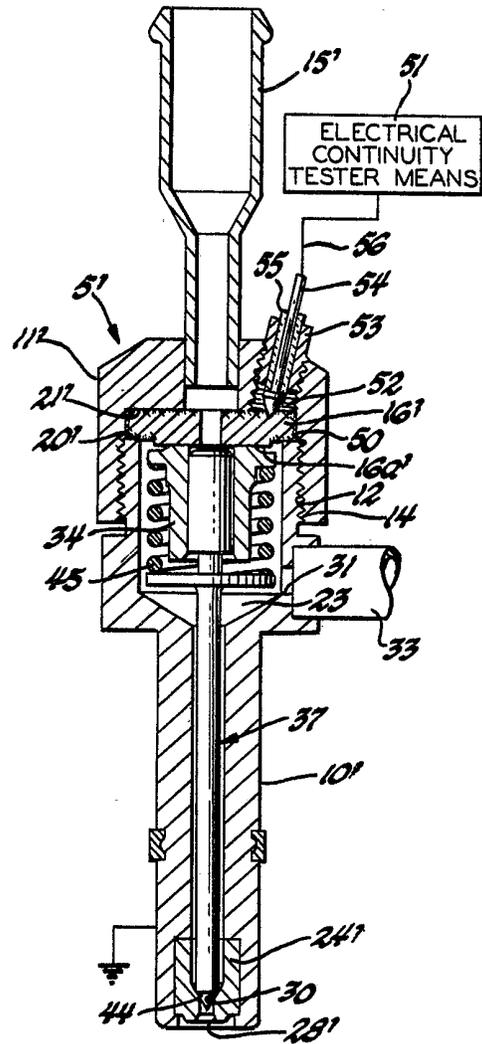
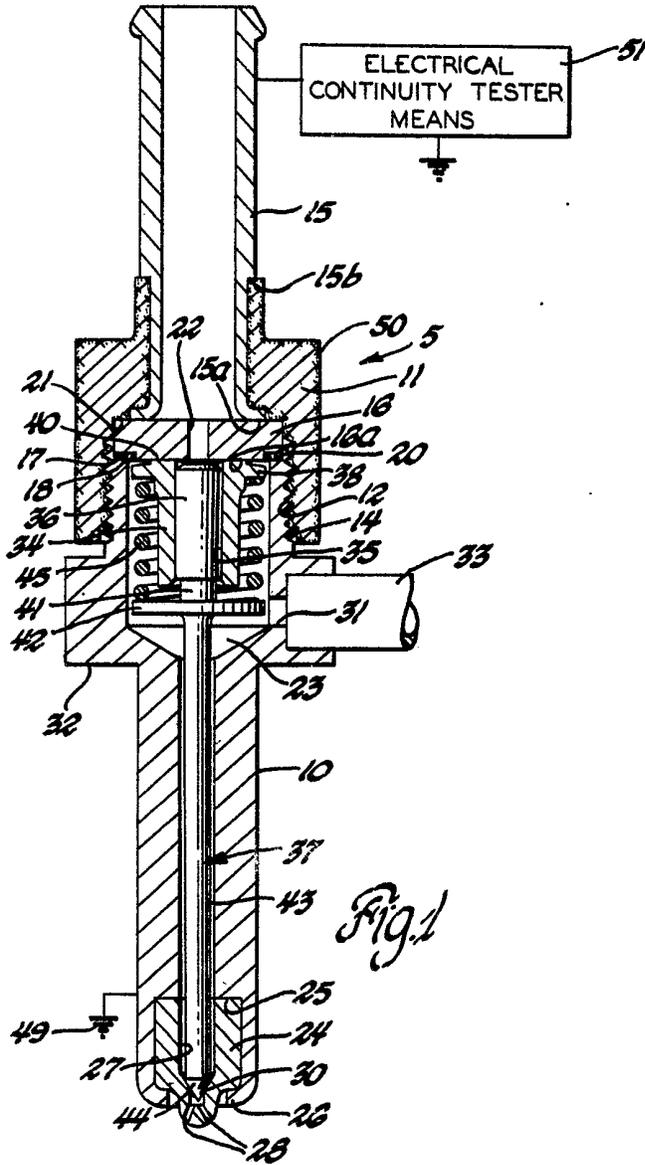
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(54) Fuel injection timing nozzles

(57) An inwardly opening valve nozzle 5 is provided with electrical insulation between the body 10 containing the valve seat 30 and the movable valve 37 so that when the valve is closed an electrical circuit can be completed through the valve and body and when the valve is moved to an open position, the continuity of this circuit is

broken. By connecting an electrical continuity tester to this circuit, the opening and closing of the valve can be detected and can be used to set the timing of a diesel engine. The insulation may be provided by parts 11 and 18 of electrical insulating material or of aluminium with an surface oxide layer or the spacer 16 may have an insulating layer or be located by insulating members (18", 60), Fig. 3 (not shown).





SPECIFICATION

Fuel injection timing nozzle

This invention relates to a diesel engine timing device and, in particular, to injection timing nozzles for use in diesel engines.

The desirability of a timing mechanism whereby the start of fuel injection and the duration of fuel injection of a fuel injection nozzle, as used in diesel engines, may be quickly and accurately ascertained has been recognized.

According to the present invention an otherwise conventional diesel fuel injection nozzle, of the inward opening valve type, has certain parts thereof electrically insulated from the remainder of the nozzle assembly whereby, when the nozzle is connected in an electrical circuit with an electrical continuity tester, a continuous electrical circuit is effected when the injection valve is in a closed position seated against its valve seat and when the injection valve lifts off its seat, injection begins and the continuity of the electrical circuit is broken. In effect, the fuel injection nozzle according to the invention is also operative as an on-off type electrical switch having a fixed contact and a movable contact.

It is, therefore, a primary object of this invention to provide a fuel injection nozzle which is electrically connectable to an electrical continuity tester and which is operable upon opening of its injection valve to break an electrical circuit.

Another object of this invention is to provide an otherwise conventional diesel fuel injection nozzle with certain elements thereof insulated from the other elements thereof whereby the injection nozzle is also operative as an electrical switch,

The invention enables the time of the beginning of fuel injection and the duration of fuel injection in a diesel engine to be quickly and accurately ascertained.

Embodiments of the invention are hereinafter particularly described with reference to the accompanying drawings, in which:—

Figure 1 is a vertical section through a first embodiment of an injection timing nozzle in accordance with the invention;

Figure 2 is a vertical section of a second embodiment of an injection timing nozzle in accordance with the invention; and,

Figure 3 is a vertical section of a portion of a third embodiment of an injection timing nozzle in accordance with the invention.

Figure 1 shows a fuel injection timing nozzle 5 with an injector nozzle housing or body, of generally cylindrical configuration, that includes a spray tip body 10 and an inverted, cup-shaped cap 11 secured together by internal threads 12 of the cap engaged with external threads 14 on the upper end of the spray tip body 10. The cap 11 has a central stepped bore therethrough to receive the reduced diameter end of a spill tube 15 which is fixed to the cap 11 by having its lower end spun radially outward to form a flange 15a whereby the cap 11 is axially sandwiched between this flange 15a and a radial shoulder 15b of the spill tube 15.

An abutment or guide spacer 16, in the form of a disc provided with a recessed annular groove 17 adjacent its lower outer peripheral edge, and a washer 18 received in this groove are sealingly sandwiched between the upper rim 20 of the spray tip body 10 and an internal, annular shoulder 21 of the cap 11, and in abutment with the flange 15a of the spill tube, for a purpose to be described hereinafter. A central aperture 22 through the guide spacer 16 is used to effect communication between the spill tube 15 on one side thereof and the chamber 23 formed on the opposite side of the guide spacer 16 by this spacer and the axial stepped bore through the spray tip body 10.

In the construction shown, the spray tip body 10 has an injector tip 24 secured to its lower end by having this spray tip 24 sandwiched between an internal shoulder 25 of the body and a flange 26 formed by inwardly swaging over the lower end of the spray tip body 10. Injector tip 24, as thus positioned, has an axial passage 27 which is in communication at one end with the lower or reduced diameter end of fuel chamber 23 and, at its other end, with one or more spray orifices 28. The spray tip 24 also has an annular valve seat 30 located in the passage 27 upstream of the spray orifices 28, in terms of the direction of fuel flow through the passage 27 to these spray orifices.

Spray tip body 10 has a radial inlet port 31 located above an external mounting abutment shoulder 32 of this body, the inlet port 31 opening at one end into the fuel chamber 23 and being in flow communication at its other end with a conventional conduit coupling 33 that is secured to the spray tip body 10, as by welding, whereby the injection nozzle can be connected to a conventional fuel injection pump, not shown, that is operative for delivering fuel under predetermined pulsating pressure.

Located within the upper end of fuel chamber 23 and laterally spaced from the internal wall of the spray tip body 10 defining this portion of the fuel chamber is a sleeve or bushing 34 having a central guide stem bore 35 therethrough for slidably engaging and supporting the upper, enlarged, predetermined diameter stem end 36 of an inward opening, needle type injection valve 37.

The upper enlarged end of the bushing 34 provides an external radial flange 38 having an annular valve rim 40 at its upper end of a predetermined diameter sufficient for the rim to encircle the aperture 22 at a distance radially outward thereof so that, when the bushing 34 is in the position shown with its valve rim 40 in abutment with the lower surface 16a of the guide spacer 16, it will be operative to act as a valve to block direct fluid communication between the interior of the spill tube 15 and the chamber 23.

In the construction shown, the injection valve 37 include the upper enlarged diameter stem end 36, an intermediate reduced diameter stem portion 41, of predetermined diameter, connecting the stem end 36 to an enlarged radial flange or collar 42 and, an elongated stem 43, also of

predetermined diameter, depending from collar 42 to terminate at a conical valve tip 44 of a size and configuration to seal against the valve seat 30.

A coil spring 45, of a predetermined spring load, is positioned in the chamber 23 so as loosely to encircle the lower end of the bushing 34 with one end thereof in abutment with the underside of the flange 38 of bushing 34 and with its opposite end in abutment with the collar 42 of the injection valve 37. Spring 45 thus acts as a biasing means so as normally to maintain the bushing 34 closed against the lower surface 16a of guide spacer 16 and, the injection valve 37 closed against its valve seat 30 upstream of the spray orifices 28.

With the injection valve 37 in its closed position, as shown, a spacing exists between the upper end of the stem end 36 of the injection valve 37 and the lower surface 16a of the guide spacer 16, the axial extent of this spacing limiting the maximum extent of injection valve 37 opening. For this purpose, the axial extent of bushing 34 is preselected so as to provide a spacing of a larger axial extent between the lower end of this bushing and the collar 42 of the injection valve 37.

The nozzle 5, as thus far described, is of conventional construction except that it has a conduit coupling 33 whereby the chamber 23 can be intermittently supplied with pressurized fuel and has a spill tube 15 whereby any fuel leaking past the movable mating surface of the stem end 36 of the injection valve 37 and the guide stem bore 35 in the bushing 34 can flow through the aperture 22 in the guide spacer 16 into this spill tube 15 for return to a fuel reservoir, not shown, in a conventional manner known in the art.

As is well known, the elements of fuel injection nozzles of this type are normally made of suitable hard and strong materials, such as steel, which are capable of withstanding the normal working pressures and temperatures such nozzles are subjected to as used in diesel engines. Normally these materials, such as steel, used in these injection nozzles are also electrically conductive.

In accordance with the invention, a part or parts of such an otherwise conventional fuel injection nozzle are made so as to be electrically insulated relative to the remaining electrically conductive components or parts of the assembly whereby the nozzle can then also be operative as an electrical switch.

Thus with reference to the embodiment shown in Figure 1, the cap 11 and the washer 18, in accordance with the invention, are used to electrically insulate the electrically conductive spill tube 15 from the electrically conductive spray tip body 10 and also to electrically insulate the electrically conductive guide spacer 16 from the spray tip body 10, respectively.

For this purpose, the cap 11 and washer 18 may be made of a suitable hard, electrically insulating material or, as shown, they may be made of an otherwise conductive metal and then provided on their surfaces with an integral insulating layer 50. For example, in the particular construction shown, both the cap 11 and the

washer 18 are made of aluminium with the inner and outer surfaces of each of these parts anodized, whereby there is provided on each part an outer aluminium oxide layer which is operative to serve as the integral insulating layer 50 of that part.

With the injection timing nozzle 5 of Figure 1 thus constructed, a conventional electrical test circuit such as an electrical continuity tester, shown schematically at 51, can be electrically connected between the spill tube 15 and the spray tip body 10. As is well known, such testers normally include, as part of the circuit thereof, a source of electrical energy, such as a vehicle storage battery, not shown, that is used to provide a signaling device, such as a lamp, an alarm, or some other form of signal or indicator device.

The circuit of the electrical continuity tester 51 may be such that the signaling device is energized when there is a closed electrical circuit, the signaling device is energized only when the circuit being tested is broken or alternately the signaling device is momentarily energized both when the circuit is broken and again when the continuity of the circuit is again completed. The latter type arrangement is preferred for use with the subject injection timing nozzle, since both the start and end of injection will be indicated during operation of the nozzle in the manner to be described.

It will be apparent from Figure 1 that with the injection valve 37 in its closed position, as shown, and with the electrical continuity tester 51 electrically connected to the spill tube 15 and to the spray tip body 10, an electrical circuit is completed via the spill tube 15 engaging the guide spacer 16, bushing 34 engaging guide spacer 16, bushing 34 and spring 45 engaging injection valve 37 and then injection valve 37 seated against the valve seat 30 and therefore engaging the spray tip body 10 and then via ground 49 back to the electrical continuity tester 51.

However, upon the admission of fuel at high pressure into the chamber 23, as intermittently supplied by a supply pump, not shown, via conduit coupling 33, this fuel under pressure acting on the differential area of the injection nozzle 37 will cause it to move to an open position, that is, to move axially upward with reference to Figure 1 against the bias of spring 45, causing its valve tip 44 to raise off the valve seat 30 whereby to permit fuel under pressure in chamber 23 to be discharged through the spray orifices 28.

Since both the cap 11 and guide spacer 16 electrically insulate the spill tube 15 from the spray tip body 10, when the valve tip 44 of the injection valve 37 lifts off the valve seat, the previously described electrical connection between the spill tube 15 and the spray tip body 10 when the injection valve 37 is in its closed position is now broken. This breaks the electrical continuity of the electrical circuit and this discontinuity will then be indicated by the signaling device of the electrical continuity tester 51.

At the end of an injection cycle when the

pressure of fuel in chamber 23 has decreased to a predetermined value, the spring 45 will again be operative to bias the injection valve 37 to its closed position against the valve seat 30 and thereby effect a closure of the electrical circuit by electrically connecting the spill tube 15 to the spray tip body 10 via the injection valve 37 in the manner described, this occurrence of this event being signaled by the signaling device of the electrical continuity tester 51. It is thus apparent that the injection timing nozzle 5 is operative as an electrical on-off switch in the described electrical circuit, the switch being in its on position when the injection valve 37 is in its closed position and being in its off position when the injection valve 37 is in its open position permitting discharge of fuel out through the spray orifices. With this arrangement, the spray tip body 10 serves as the fixed contact while the injection valve 37 serves as the movable contact of this electrical switch structure.

An alternative embodiment 5' of an injection timing nozzle in accordance with the invention is shown in Figure 2, wherein similar parts are designated by similar numerals but with the addition of a prime (') where appropriate. As shown, the injection timing nozzle 5' is structurally and functionally similar to the nozzle 5, except for having but a single spray orifice 28' in the injector tip 24' at the lower end of its spray tip body 10'. In this embodiment, the cap 11' of this nozzle assembly is made of electrically conductive material, such as steel, but the abutment or guide spacer 16' thereof, in the construction shown, is made of aluminium and at least the outer surfaces thereof, except for its lower surface 16a' engaged by the bushing 34, is anodized so that it has an integral insulating, aluminium oxide surface layer 50.

To permit connection of an electrical continuity tester means 51 to this injector timing nozzle 5', the cap 11' is provided with an internally threaded aperture 52 through the base thereof at a position radially outwards from the spill tube 15'. This threaded aperture is adapted to receive a hollow hexagonal head screw 53 that is used to secure and effect penetration of the sharp point of a metal conductor probe 54 operatively connected by an electrical conduit 56 to an electrical continuity tester 51. A flanged insulator bushing 55 is positioned to encircle the probe 54 and electrically insulate it from the screw 53 and therefore from cap 11'. With this arrangement, the sharp point of the probe 54 can be forced through the aluminium oxide insulating layer 50 on the upper surface of the guide spacer 16' to effect electrical contact with the conductive aluminium body portion of this member. Since the lower surface 16a' of the guide spacer 16' is not provided with an anodized surface, an electrical connection is effected between the probe 54 and the body of guide spacer 16' to the injection valve 37 via the bushing 34 and spring 45.

Thus in this nozzle 5' structure, when its injection valve 37 is in its closed position with the valve tip 44 thereof seated against valve seat 30

of injector tip 24', an electrical circuit is completed through the injection timing nozzle 5' and, when the injection valve 37 is lifted off this valve seat 30 to effect the start of injection, the circuit is broken and this occurrence will then be signaled by the signaling device of the electrical continuity tester 51. As in the previously described embodiment, when the injection valve 37 is again seated at the termination of injection, this will again complete the electrical circuit which event will also be signaled by the electrical continuity tester 51.

Another alternative embodiment 5'' of an injection timing nozzle in accordance with the invention is shown in Figure 3, wherein similar parts are designated by similar numerals but with the addition of a double prime (") where appropriate. In the injection timing nozzle 5'', the cap 11'' thereof can be made of a conductive material, but the injection nozzle 37 is effectively insulated from the spray tip body 10 and cap 11'' when in its raised, open position by means of an insulator washer button 60, with a central aperture 61, that is sandwiched between the upper surface of the guide spacer 16 and by means of an insulator 18'' of cup-shaped configuration, that encircles the lower end of the guide spacer and which is sandwiched between the guide spacer 16 and the upper rim 20 of the spray tip body 10.

Both the insulator washer button 60 and insulator washer 18'' can be made of a hard insulating material or alternatively, if desired, they can be made of a conductive material having an outer integral insulating coating or layer thereon. In the particular construction shown, both the insulator button 60 and insulator washer 18'' are made of aluminium and each has the outer surfaces thereof anodized so as to provide an insulating aluminium oxide layer 50' thereon.

To effect an electrical connection between an electrical continuity tester 51 and the injection valve 37 of the nozzle 5'', its cap 11'' is provided with a side aperture 57 that is aligned with an unprotected portion of the guide spacer 16 of this nozzle 5'', whereby a conductive probe 54 connected to one end of the tester 51 can be inserted to effect a circuit connection to this guide spacer 16, the other end of the tester 51 being electrically connected to the spray tip body 10 of this nozzle 5''. Preferably, an insulator bushing 55, as shown, is positioned to encircle the probe 54 intermediate the ends thereof so that it will not contact the cap 11''.

With the electrical continuity tester 51 operatively connected in series between the guide spacer 16 and the spray tip body 10 of the injection timing nozzle 5'', this nozzle, like the nozzles 5 and 5', will effect with the electrical continuity tester 51 a continuous electrical circuit when the injection nozzle 37 is in its closed or seated position and when the injection nozzle 37 is in its open or lifted position, this circuit will be broken.

When the fuel injection nozzle is used as one of

the injector nozzles in a diesel engine, the signaling device of the electrical continuity tester 51, preferably has a signalling device in the form of a lamp, such as a strobe light, not shown, which can be positioned so as to illuminate timing indicia on a convenient movable portion of the engine whereby the start of injection from the injection timing nozzle can be timed relative to the top dead centre position of the cylinder associated with the injector and permit the operator to effect desired timing of the engine.

CLAIMS

1. A fuel injector nozzle, in which a housing with an inlet for pressurized fuel has at one end an electrically conductive spray tip body which is connectible to one end of an electrical test circuit and within which an electrically conductive injection valve is reciprocable relative to a valve seat in said body to open or close a spray tip outlet at the free end thereof, a spring and an abutment operatively connected to said housing and said injection valve being arranged so as normally to bias said valve to close said outlet, and said abutment being connectible to the opposite end of said test circuit and including insulation arranged so as electrically to insulate said spray tip body from said injection valve when the valve is in its open position.

2. A fuel injection nozzle according to claim 1, in which said nozzle housing includes a cap having a spill tube extending therefrom fixed to the end of said spray tip body opposite said spray outlet, said abutment being of electrical conductive material and having a central through aperture therein, and said spring has therein a bushing of electrical conductive material having a central guide bore therethrough slidably receiving the end of said

injection valve opposite said valve seat, said spring being operatively connected to said bushing so as normally to bias it into seating contact with one side of said abutment.

3. A fuel injection nozzle according to claim 2, in which said cap includes insulation arranged to insulate said spill tube electrically from said spray tip body, said spill tube being electrically conductive and positioned to abut the opposite side of said abutment so that said injection valve is operatively connectible to said electrical test circuit via said bushing, said abutment and said spill tube.

4. A fuel injection nozzle according to claim 2, in which said insulation is a layer of insulating material covering all but the said one side of said abutment engaged by said bushing, and said cap has an aperture therethrough aligned with a portion of said abutment to enable a pointed electrical probe of said electrical test circuit to be inserted through said aperture to penetrate said layer of insulating material and effect an electrical connection with the conductive material of said abutment.

5. A fuel injection nozzle according to claim 2, in which said insulation includes insulating washers positioned on opposite sides of said abutment so that said abutment is positioned between and electrically insulated from said cap and said spray tip body, and said cap has an aperture therethrough to enable an electrical connection to be made from said abutment to the opposite end of the electrical test circuit.

6. A fuel injection nozzle constructed and adapted to operate substantially as hereinbefore described with reference to and as shown in Figure 1, 2 or 3 of the accompanying drawings.