

[54] **ANTI-FOULING SPARK IGNITION DEVICES**

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[51] Int. Cl. **H01t 13/02**

[58] Field of Search **123/169 R, 169 CL, 169 CM, 123/169 CA, 169 CB, 169 DW, 169 EL, 169 EC, 169 C, 169 E, 169 G, 169 P, 169 PA, 169 PB, 169 PH, 169 V; 313/138**

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[57] **ABSTRACT**

An axially elongated member is provided with an antechamber at one end thereof for receivably engaging the firing end of a spark ignition device. The axially elongated member includes a diverging-converging exit nozzle in its other end and a narrow bore or port extending between and connecting the antechamber with the exit nozzle. The nozzle's exit aperture is formed in the end face of the member and thus defines an annular baffle means axially displaced from the point where the narrow bore opens into the exit nozzle. Because of its diverging-converging construction the interior recess of the nozzle is enlarged with respect to the diameter of its exit aperture which latter, in turn, is enlarged with respect to the diameter of the narrow bore or port. The axial member further includes means for preventing a fluid flowing along a wall surface perpendicular to the axis thereof from flowing over the end face of its other end and entering the enlarged interior recess of the exit nozzle.

18 Claims, 5 Drawing Figures

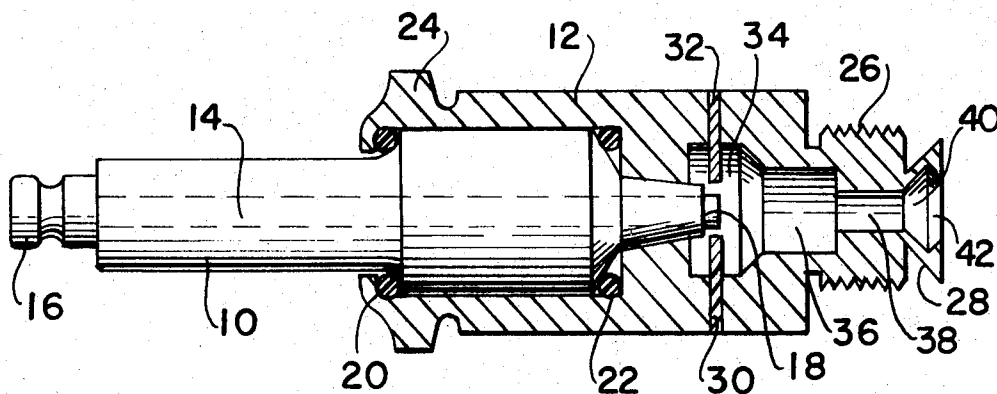


FIG. 1.

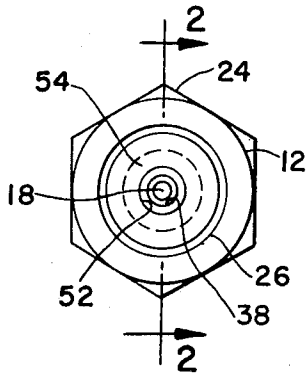


FIG. 2.

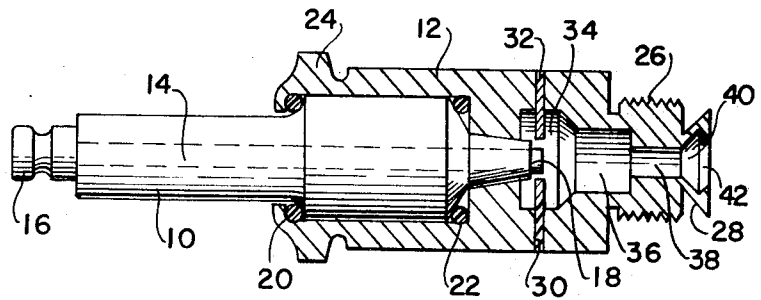
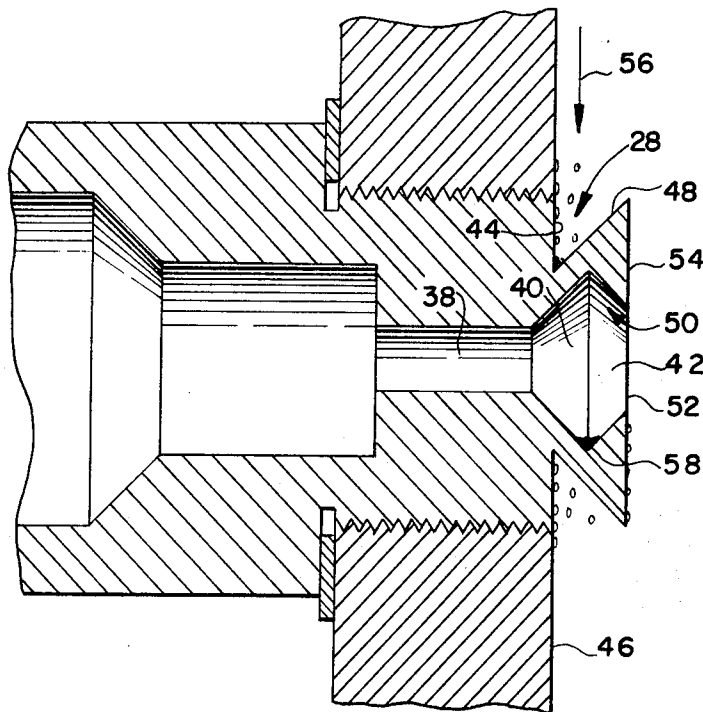


FIG. 3.



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FIG. 4.

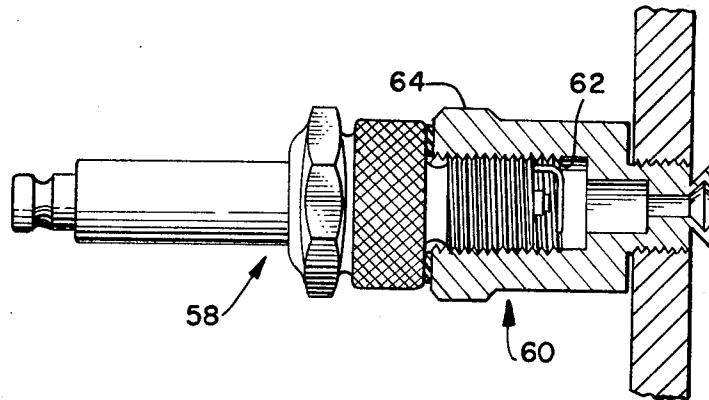
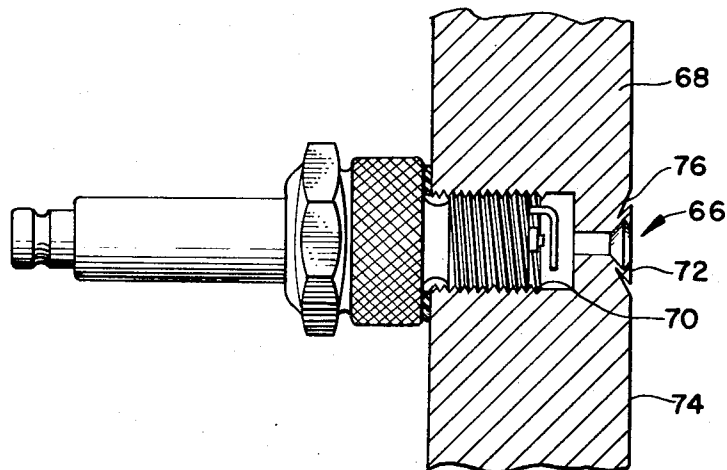


FIG. 5.



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ANTI-FOULING SPARK IGNITION DEVICES

The present invention relates generally to spark ignition devices and more particularly to an improved anti-fouling spark plug for use in internal combustion engines or the like. The term anti-fouling spark plug as applied to the present invention refers to a spark plug having means associated therewith for preventing oil, carbon, and other debris from lodging in or near the electrode gap of the plug and thus preventing such foreign matter from interfering with the proper operation of the plug.

Anti-fouling spark plugs have been proposed heretofore wherein the spaced electrodes forming the sparking gap are recessed in an antechamber formed in an axially protruding extension of the spark plug's shell. The chamber which completely encloses the sparking electrodes at one of its axial extremities, communicates with a narrow apertured bore or port at its other opposed extremity. This port or bore communicates, in turn, with the principle combustion chamber or cylinder of the internal combustion engine with which the plug is used. By situating the electrodes at one end of the antechamber and providing a narrow apertured bore at the other opposed end of the antechamber the spark plug's electrodes are normally shielded or baffled from the oil and debris swirling about in the engine's combustion chamber. However, the atomized fuel/air mixture can easily penetrate the narrow bore opening to the antechamber and may readily be ignited when the spark plug fires. The resulting flames are then expelled through the narrow bore because of the rapid pressure increase in the antechamber to ignite the main mixture in the principle combustion chamber.

Although the prior art anti-fouling spark plugs have generally operated satisfactorily with certain types of internal combustion engines, they have been found to suffer from the major disadvantage of being extremely critical with regard to their location. In a great many modern internal combustion engines, particularly those used in automobiles, trucks, and other vehicles, the spark plug receiving ports in the engine wall are positioned so that the plug's firing end extends into the combustion chamber below the cylinder's intake and exhaust valves. In addition, when the plugs are screwed into their corresponding ports, they usually assume a slightly tilted attitude with respect to a local horizontal direction, that is, with the firing end of the plug being slightly raised with reference to its terminal or rearward end. Such engine arrangements are generally referred to as being of the overhead valve type.

It is well known that droplets of lubricating oil occasionally seep or escape through the valve stem seals in such engines, especially when the latter have been in use for a considerable time and are beginning to show signs of wear. These droplets of oil tend to flow downwardly along the walls of the combustion chamber under the influence of gravity until eventually they reach the exposed electrodes of the plugs, causing fouling and improper firing of same. Even when anti-fouling plugs are employed, the oil manages to flow into and through the narrow bore or port of the plug's antechamber and because of the slight upward cant of the plug, readily pools or collects around the electrodes thus fouling the plug nonetheless. Only when the anti-fouling plug is mounted in an engine where the orienta-

tion of the spark plug receiving ports requires the firing end of the spark plug to be lower than the plug's rearward or terminal end will gravity help to keep oil from pooling at the electrodes and eventually causing improper firing thereof. It is readily apparent therefore that such prior art anti-fouling plugs are in fact, totally ineffectual in preventing fouling due to oil pollution when used in engines requiring a static mounting position for the plugs that is more or less horizontal.

Accordingly, it is the primary object of the present invention to provide an improved spark plug means having unique features of construction for effectively preventing fouling of the plug's electrodes by foreign matter or debris.

It is another object of the present invention to provide an improved spark plug means that is particularly resistant to the fouling effects of oil.

It is yet another object of the present invention to provide an improved anti-fouling spark plug means that can be mounted in a substantially horizontal static operating position in an internal combustion engine, yet will not be affected by the polluting effects of oil or other engine debris.

To the accomplishment of these and other objects and advantages, the improved anti-fouling spark plug means of the present invention comprises an axially extending outer shell member including an interior cavity adapted for receiving therewithin a sparking discharge means. The outer shell member further comprises a terminal portion adapted to extend into the combustion chamber or cylinder of an internal combustion engine and has a diverging-converging recess formed interiorly thereof to define an exit nozzle or chamber. The cavity and the chamber are connected by a narrow axial bore or port having a diameter smaller than the mouth or exit aperture of the chamber which aperture, in turn, has a diameter smaller than the major diameter of the chamber itself. A second grooved annulus formed exteriorly on the outer shell member's terminal portion near the shell member's axial extremity completely surrounds the exit aperture of the nozzle.

Additional features and advantages of the present invention will be made more apparent from a study of the following detailed description of the invention in connection with the accompanying drawings wherein:

FIG. 1 is a front view of the improved spark plug of the present invention;

FIG. 2 is a sectional view in side elevation of the spark plug of FIG. 1 taken along line 2-2;

FIG. 3 is an enlarged detail view of a fragmentary portion of FIG. 2;

FIG. 4 is a side view partly in section of an alternate preferred form of the present invention, and;

FIG. 5 is a side view partly in section of yet another alternatively preferred form of the present invention.

Turning now to FIGS. 1 and 2, there is shown one preferred form of the improved spark plug according to the present invention comprising an insulating core member 10 coaxially received within an outer shell member 12. The core member 10 which may be of porcelain, ceramic or other such heat resistant non-conductive material, has longitudinally disposed therein an elongated central electrode 14. One end of electrode 14 is integrally connected to a conductive terminal post 16 while its opposed other end protrudes slightly from

the tapered end portion of the insulating core member as shown at reference numeral 18. The core member is clamped in or otherwise fixedly secured to the outer shell member with a pair of sealing gaskets or the like 20 and 22 being disposed therebetween. It will be appreciated that any conventional method of clamping the core member within its outer shell may be employed, and since this aspect of construction forms no part of the present invention, it need not be further discussed herein.

As viewed in FIG. 2, outer shell member 12 has formed exteriorly thereon near its left most end, a radially flanged portion 24 having suitable hexagonally faced edges (FIG. 1) capable of receiving a spanner wrench or similar tool. The right-most or extreme axial end of the outer shell member terminates in a portion of reduced size having suitable threads 26 thereon for cooperatively engaging the spark plug receiving port of an internal combustion engine. As will be explained in more detail below, the extremity of this reduced-size threaded end portion of the outer shell member is necked-down to form a substantially V-shaped grooved annulus 28 concentrically surrounding the mouth or firing end of the spark plug.

The outer shell member carries a pair of opposed ground electrodes 30, 32 which extend laterally into a cavity 34 formed within the interior of the outer shell member and surrounding the protruding end 18 of the central electrode 14. Each ground electrode 30, 32 is radially spaced from the common center electrode 14 so as to form a pair of sparking gaps in conjunction therewith. As will occur to those skilled in the art, and depending upon individual requirements, a single ground electrode (not shown) extending into cavity 34 in axially spaced relation to central electrode 14 may be used to form a single gap instead of the two formed when the dual electrodes 30, 32 are employed. As shown, cavity 34 opens into another cavity 36 interiorly of outer shell/member 12 and the two cavities 34 and 36 together define an antechamber therein completely enveloping the sparking gaps formed among spaced electrodes 14, 30 and 32 at one end thereof. An axial connecting port or bore 38 having a diameter of reduced size extends between cavity 36 at the other end of the antechamber and a pair of inverted frusto conical chambers 40 and 42 forming the mouth or exit nozzle for the spark plug. With this construction, a mixture of atomized fuel and air can easily enter the antechamber (cavities 34 and 36) and be ignited by a spark discharge across the electrode gaps defined by electrodes 14, 30, 32. The rapid pressure increase accompanying such ignition within the confines of the antechamber will expell a jet or tongue of flame through the port 38 and the exit nozzle of the plug thereby igniting the main mixture inside the principal combustion chamber of the engine.

On the other hand, due to the advantageous unique construction of the present invention, all forms of particle debris or foreign matter and in particular, engine lubricating oil, are effectively prevented from entering the antechamber and polluting the spark plug's electrode gaps as will now be explained with reference to FIGS. 1 and 3 wherein like reference numerals represent like parts. It was mentioned previously that the mouth or exit nozzle of the spark plug is surrounded

by a substantially V-shaped groove or annulus 28. As indicated in the enlarged detail of FIG. 3, this groove or annulus is machined or otherwise formed so that preferably one of its sides or walls 44 is coplanar with respect to the inner wall surface 46 of the engine's principle combustion chamber when the spark plug is screwed in place. The other side or wall 48 thus formed by groove 28 extends away from the wall surface 46, at an acute angle, to form a flared or funnel shaped protrusion extending slightly into the engine's principle combustion chamber as shown. Concentrically disposed within this flared extremity of the spark plug is the exit mouth or nozzle previously alluded to comprising the two inverted frusto conical chambers 40 and 42. Preferably, the exit mount and more particularly, the two frusto conical chambers 40 and 42 are formed by machining a second V-shaped annular groove 50 in the protruding extremity of the outer shell member after bore 38 has already been formed therein. In accordance with the present invention the outer frusto conical chamber 42 and the inverted inner frusto conical chamber 40 formed by groove 50 are arranged substantially as shown in FIG. 3 with the diameter of the exit aperture 52 formed by the inter-section of chamber 42 with the flat outer end face 54 of the flared extremity of the plug being greater than the diameter of the port or bore 38 as clearly shown in FIGS. 1 and 3. In addition, the diameter defined by the imaginary base common to the two inverted frusto conical chambers is greater than the diameter of exit aperture 52 as is also clearly illustrated in FIG. 3. Since the diameter of the exit mouth will be at a maximum along the imaginary common base defined by the two inverted frusto conical chambers 40, 42 this diameter may be referred to hereinafter and in the appended claims as the exit mouth's "major diameter."

In operation, it will be appreciated that the overhanging construction of the flat end face 54 of the plug's axially protruding extremity provides an annular radially extending shield or baffle that is effective in preventing substantially all impinging particles of carbon or other debris from entering the port or bore 38. Only if such particles have a substantially flat trajectory do they stand a chance of entering the mouth or bore of the plug. And when this occurs, the entering particles are usually expelled during the next firing of the plug by the jet of flame issuing through the port 38.

Moreover, due to the V-shaped grooved annulus 28 surrounding the protruding extremity of the plug, any oil droplets flowing along the inner wall 46 of the engine's combustion chamber as indicated by the arrow 56 in FIG. 3 for example, will be entrapped by the groove and caused to flow around the flared extremity rather than flowing over the end face of the plug and into the bore 38 as is the case in prior art anti-fouling plugs. In the event some splashed oil does happen to find its way onto the protruding end face 54 and flows into the mouth defined by chambers 40, 42, the oil will merely collect or pool at the bottom of the exit mouth formed by groove 50 as represented schematically by reference numeral 58. When the pooling oil accumulates sufficiently to rise above the level determined by the lower lip of the exit aperture 52, the excess will merely flow over this lip under the influence of gravity and be discharged from the mouth. Because the major

diameter of the exit mouth is axially located relatively nearer to the exit aperture 52 than it is to the bore 38 as clearly shown in FIG. 3, and further because the exit aperture 52 is greater in diameter than the bore 38, the lip formed by the exit aperture will always be lower in elevation than the bore; hence, the accumulating pool of oil can not rise sufficiently in the mouth of the plug to establish backflow into and through the port 38 and thus into the antechamber of the plug's outer shell. It is thus seen that when the spark plug of the present invention is disposed in a nominally horizontal position as called for in great number of modern internal combustion engines, it is for all intents and purposes impervious to the deleterious effects of oil and will not foul even under conditions of severe leaking of engine-valve oil-seals.

Although the improved spark plug of FIGS. 1-3 is preferably of one-piece integral construction, it will be understood to be within the contemplation of the present invention to provide an adapter for conventional spark plugs, which when used together will produce an improved spark plug configuration having all the advantages and benefits of the one-piece construction described above in connection with FIGS. 1-3. Thus, turning now to FIG. 4, there is shown an alternate preferred embodiment of the present invention comprising a conventional spark plug generally represented at 58 received within the anti-fouling spark plug adapter generally designated by reference numeral 60. As shown, adapter 60 forms an axial extension for the spark plug and toward this end includes an internally threaded bore or cylindrical passage 62 for cooperatively engaging the conventional externally threaded inner end of the spark plug. The adapter 60 also includes a hexagonally faced flanged portion 64 adapted to be engaged by the usual spark plug spanner. In all other respects the adapter spark plug configuration of FIG. 4 is identical to the one-piece plug of FIGS. 1-3 and is used in exactly the same way, that is, the entire assembly is screwed into a corresponding spark plug receiving port in the wall of the combustion chamber or cylinder of an internal combustion engine as depicted by way of illustration in FIG. 4.

Finally, in FIG. 5, there is shown yet another alternative preferred embodiment of the present invention comprising an anti-fouling means 66 integrally formed within the cylinder or combustion chamber wall 68 of the engine as an axial extension of the conventional spark plug receiving port 70. The wall 68 has a slightly greater width than usual to accommodate the anti-fouling means 66, which latter includes the narrow apertured bore communicating with the exit mouth or nozzle formed of two inverted frusto-conical chambers as in both previously described embodiments of the invention. The anti-fouling means of FIG. 5, however, aside from its integral construction within the engine or combustion chamber wall proper differs significantly from both previous embodiments in that the axial extremity or end face 72 of the unit is flush or coplanar with respect to the inner wall surface 74 of the combustion chamber or cylinder. This, in turn, requires that an annular groove 76 concentrically surrounding the end face 72 be cut or recessed into the inner wall surface 74 so as to provide means for entrapping oil flowing along the inner wall surface in substantially the same way as

groove 28 (FIG. 3) accomplishes this function. And although the flush construction of the end face 72 and the inner wall surface 74 is disclosed herein in connection with the embodiment of FIG. 5, it will be appreciated that any of the other preferred forms of the present invention described above may be modified in a similar manner to suit those applications where even a slight projection into the combustion chamber or cylinder of the engine cannot be tolerated.

From the foregoing, it should now be apparent that the present invention provides a drastically improved spark plug device including means for effectively preventing fouling of the spark plug's electrodes despite the presence of oil or other foreign matter in the engine's combustion chamber and the unfavorable static horizontal mounting position of the spark plug.

While several preferred embodiments have been disclosed hereinabove by way of illustration, it will be understood that many alterations, modifications, and variations may be made within the spirit and scope of the present invention without departing from the principles thereof as defined in the appended claims.

I claim:

1. Apparatus for use with a spark ignition device including an insulting core body and a center electrode carried by said core body and protruding therefrom at one end thereof, comprising:

an axially extending member adapted for cooperative engagement with said spark ignition device; said member including an interior cavity for receivably enclosing said protruding center electrode, an exit mouth axially displaced from said cavity, and a connecting port extending between said cavity and said exit mouth, one end of said connecting port communicating with said interior cavity and the other end of said connecting port communicating with said exit mouth;

said exit mouth having an exit aperture axially displaced from said other end of said connecting port, the diameter of said exit aperture being greater than the diameter of said port, said exit mouth forming a diverging-converging interior recess having a major diameter axially disposed between said other end of said connecting port and said exit aperture, said major diameter of said diverging-converging recess being greater than the diameter of said exit aperture.

2. The apparatus of claim 1 wherein said axially extending member includes a remotely disposed end face defining its axial extremity, said exit aperture being located in said end face.

3. The apparatus of claim 1 wherein said major diameter of said converging-diverging recess is axially located relatively nearer to said exit aperture than to said other end of said connecting port.

4. The apparatus of claim 2 wherein said end face is substantially flat and defines an annular radially extending baffle axially displaced from said other end of said connecting port and surrounding said exit aperture.

5. The apparatus of claim 2 wherein said end face of said axially extending member is adapted for cooperation with the inner wall surface of an internal combustion engine and includes means for preventing a fluid flowing along said inner wall surface from flowing

over said end face and entering the interior recess of said exit mouth.

6. The apparatus of claim 5 wherein said last mentioned means includes an annular groove recessed into the exterior surface of said axially extending member near said end face, said annular groove being located adjacent to said inner wall surface when said member is in cooperative engagement therewith.

7. The apparatus of claim 6 wherein said end face is flush with respect to said inner wall surface.

8. The apparatus of claim 6 wherein said end face extends beyond said inner wall surface.

9. The apparatus of claim 1 wherein said insulating core body is positioned within an outer shell member surrounding said protruding electrode, and said interior cavity is adapted to threadedly receive said outer shell member in sealing engagement therewithin.

10. The apparatus of claim 1 wherein said insulated core body is positioned within an outer shell member integrally joined with said axially extending member.

11. The apparatus of claim 1 wherein said axially extending member comprises the wall of an internal combustion engine.

12. The apparatus of claim 5 wherein said axially extending member includes an externally threaded portion adjacent said end face for engaging an internally threaded spark plug receiving port communicating with said inner wall surface.

13. The apparatus of claim 1 wherein said diverging-converging interior recess forming said exit mouth comprises a pair of inverted frusto-conical chambers having an imaginary common base the diameter of which conforms to said major diameter, said common base being axially located nearer to said exit aperture than to said other end of said connecting port.

14. Anti-fouling means for use with a spark plug device, comprising: an outer shell member having an

antechamber at one end and an exit nozzle at the other end, narrow passageway means for communicating the inner end of said antechamber with the inner end of said exit nozzle, said exit nozzle having means for preventing fluid such as oil from entering the narrow passageway means and collecting in said antechamber when said outer shell member is maintained in a substantially horizontal position, said last mentioned means including an annular lip formed at the outer extremity of said exit nozzle, said annular lip defining an exit aperture of smaller diameter than the inner portion of said nozzle, said narrow passageway means being of smaller diameter than said aperture whereby any oil tending to collect within the inner portions of said nozzle will flow outwardly over said lip before backflowing through said passageway into said antechamber.

15. The apparatus of claim 14 wherein said other end of said outer shell member is adapted for cooperation with the inner wall surface of an engine, and said last mentioned means further comprises means exteriorly formed with respect to said exit nozzle in the vicinity of said wall surface for preventing said fluid as may be flowing along said wall surface from entering said exit nozzle.

16. The apparatus of claim 15 in which said means exteriorly formed with respect to said exit nozzle comprises an annular groove surrounding said exit nozzle.

17. The apparatus of claim 16 in which said annular groove defines an outwardly flared extremity at said other end of said outer shell member, said outwardly flared extremity terminating in a substantially flat end face, said exit nozzle having its exit aperture located in the plane of said flat end face.

18. The apparatus of claim 14 wherein said antechamber is adapted to receiveably engage the firing end of said spark plug device.

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