

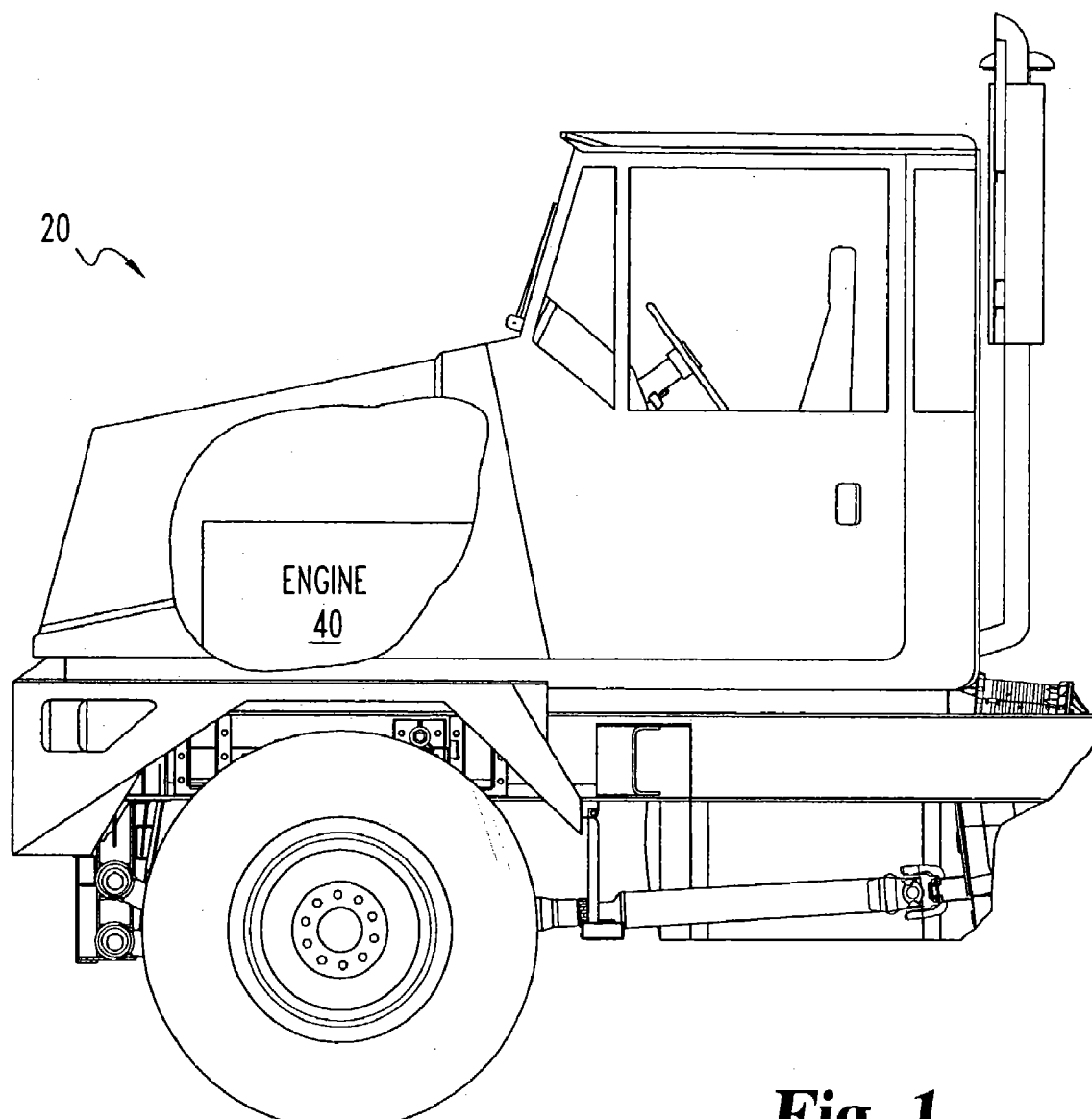


Fig. 1

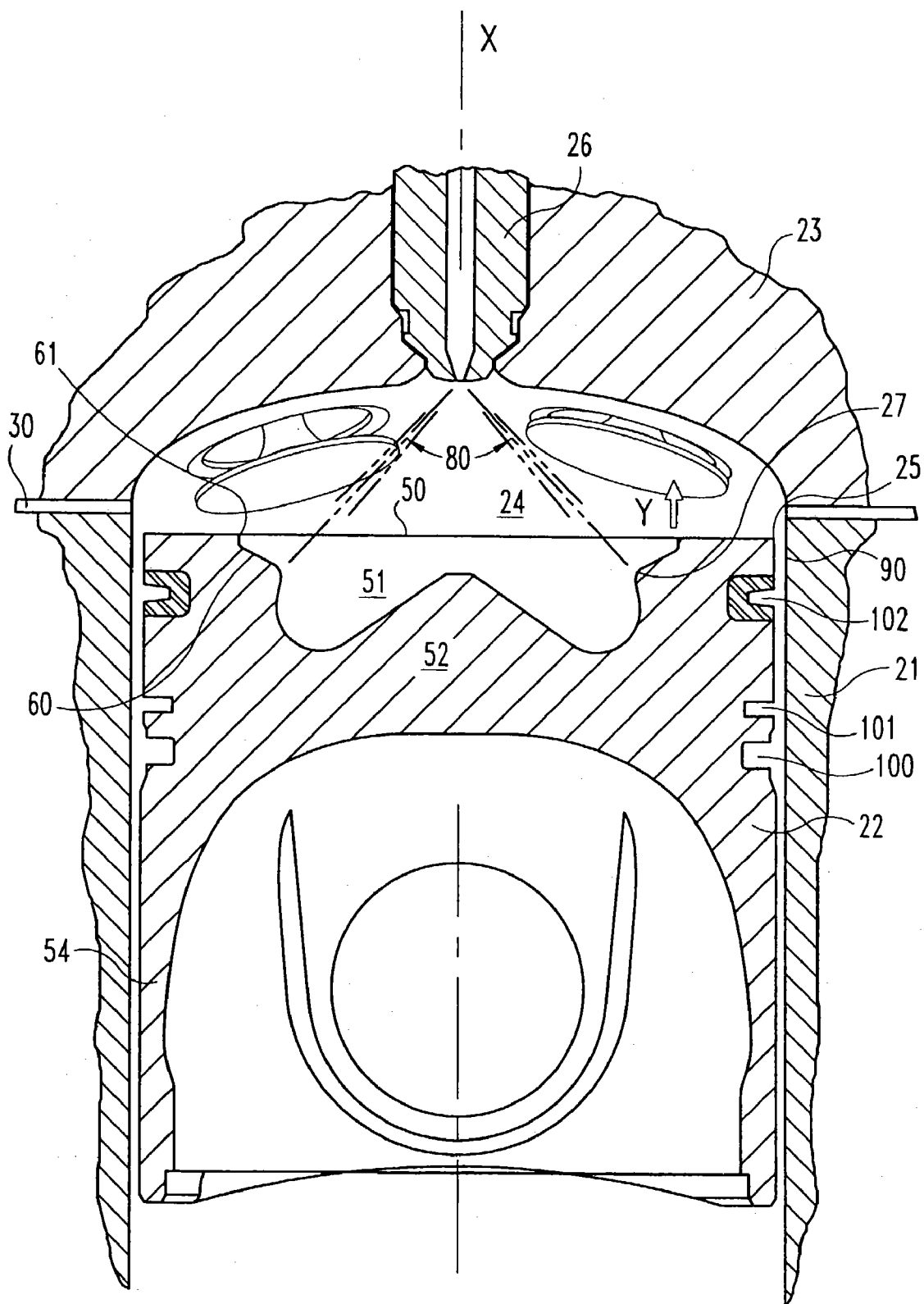


Fig. 2

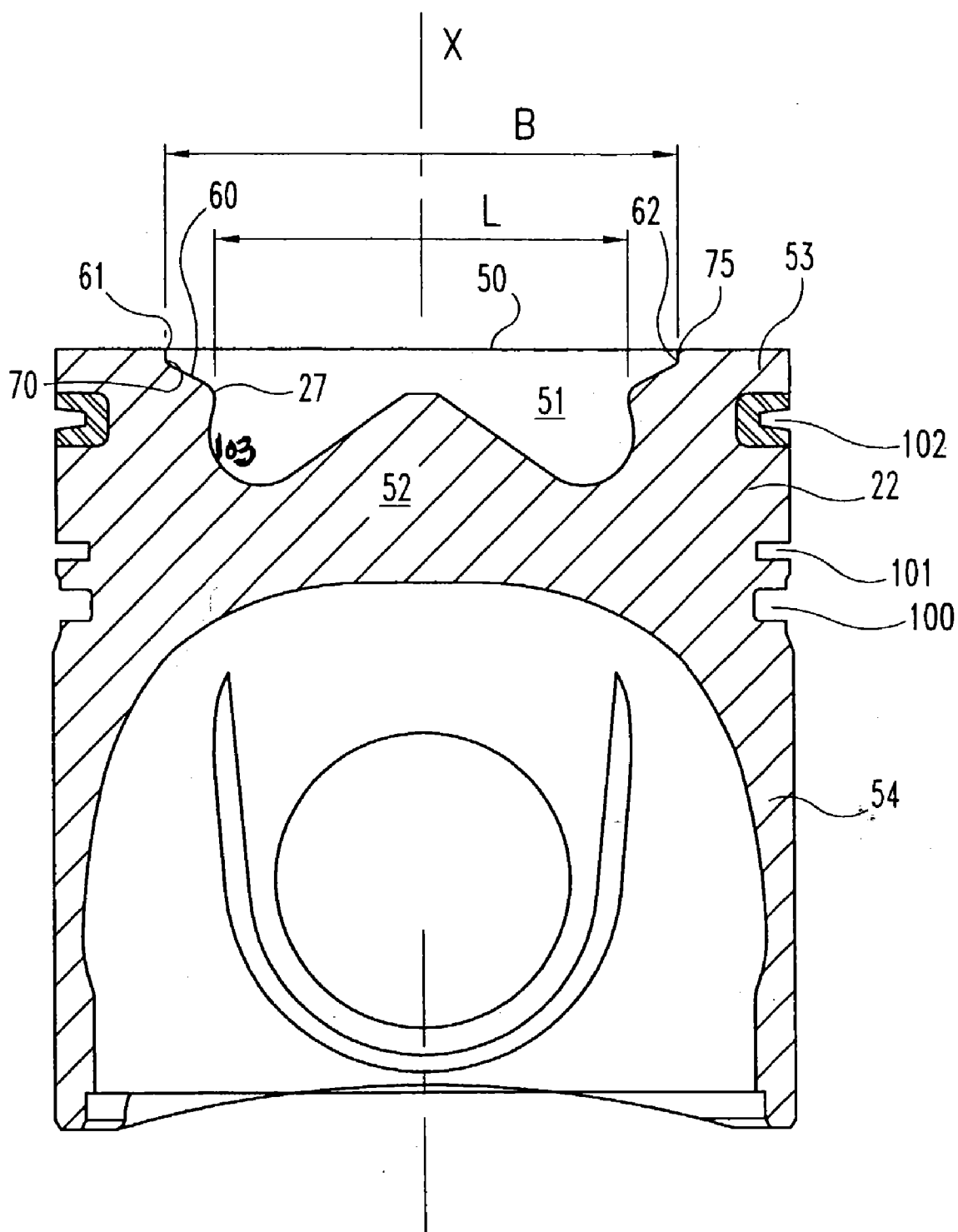


Fig. 3

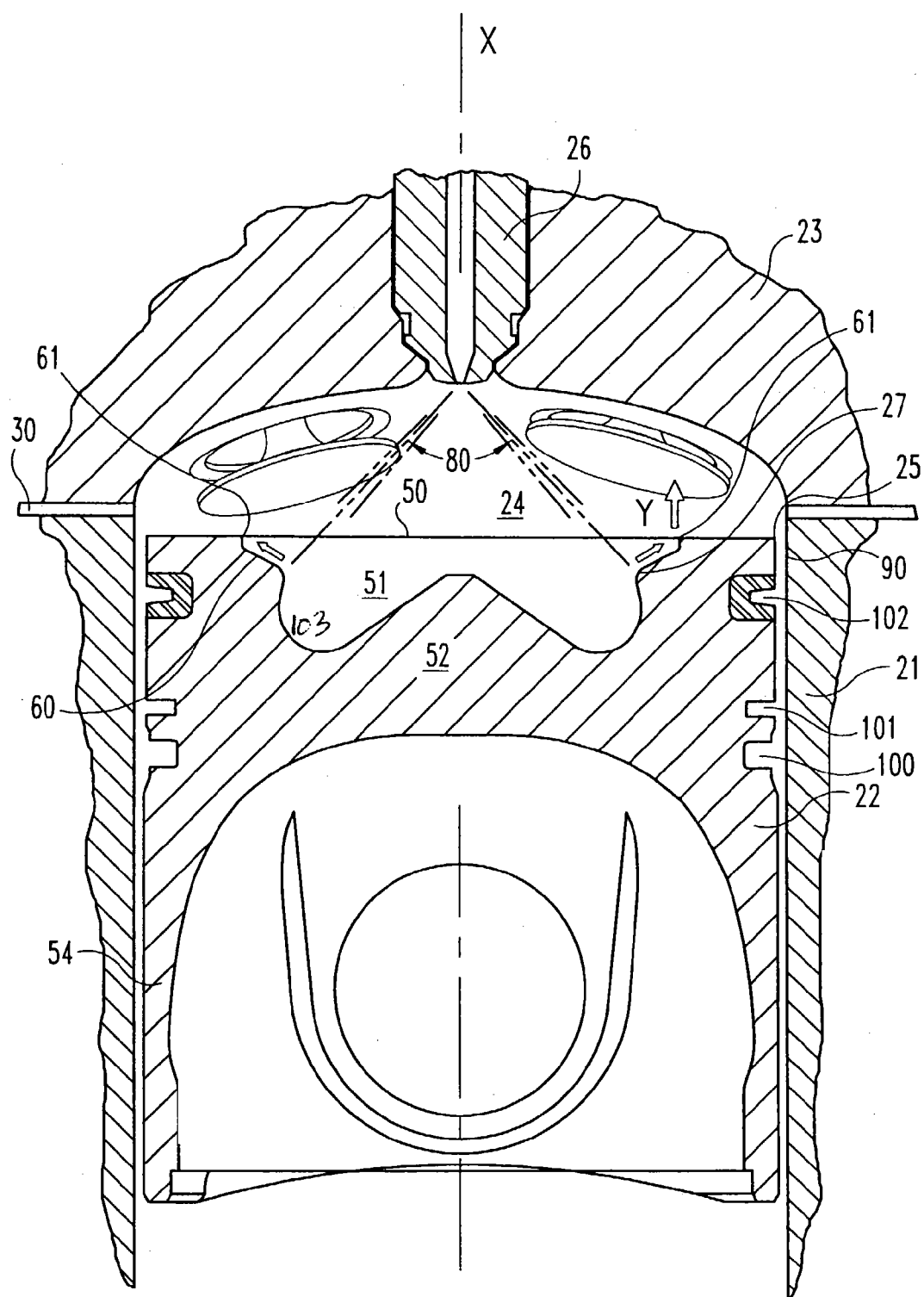


Fig. 4

INTERNAL COMBUSTION ENGINE PISTON

[0001] The present application claims the benefit of United States Provisional Patent Application Serial No. 60/392,412 filed Jun. 28, 2002, and entitled INTERNAL COMBUSTION ENGINE PISTON. The provisional patent application is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] The present invention relates generally to internal combustion engine pistons. More particularly, in one embodiment the internal combustion engine piston of the present invention includes a combustion bowl therein with fuel flow control structure for redirecting a portion of the fuel within the combustion chamber.

[0003] In view of the increasing environmental and legislative pressures worldwide to improve engine exhaust emission, engine manufacturers are focusing more attention on the development of new engines to achieve substantial reductions in emissions without compromising combustion efficiency or specific fuel consumption. One important requirement for clean combustion in an internal combustion engine is the movement of fuel within the combustion chamber.

[0004] Although many of the prior internal combustion engine piston designs are steps in the right direction, there still remains a need for additional improvement to satisfy the environmental and legislative pressures. The present inventions satisfy this and other needs in novel and non-obvious ways.

SUMMARY OF THE INVENTION

[0005] In one form of the present application there is contemplated an apparatus comprising a piston having a longitudinal centerline and a first end, the piston having a circumferential sidewall portion and a bottom wall portion defining a combustion bowl within the piston at the first end, the sidewall portion including a sharp edge at the first end of the piston and a substantially rounded lip spaced axially from the sharp edge, the combustion bowl defined at the sharp edge is round and the rounded lip is closer to the centerline than the sharp edge is to the centerline.

[0006] In another form of the present application there is contemplated an apparatus comprising a piston body having a longitudinal centerline and a first end surface, the piston body having a combustion bowl defined therein with an entrance adjacent the first end surface, the piston body having a sharp edge portion at the entrance for directing a fuel exiting the combustion bowl away from the first end surface and a rounded portion for receiving a fuel thereon within the combustion bowl, the rounded portion is located closer to the longitudinal centerline than the sharp edge portion is located to the centerline and the entrance is round.

[0007] In yet another form of the present invention, there is contemplated an apparatus comprising a piston body having a longitudinal centerline and a first end, the piston body having a circumferential sidewall portion and a bottom wall portion defining a combustion bowl within the piston, the combustion bowl having a substantially round entrance at the first end, the sidewall portion including fuel directing means at the entrance for directing a fuel leaving the combustion bowl away from the first end and fuel receiving

means for receiving a fuel within the combustion bowl, the fuel directing means is located a first distance from the centerline and the fuel receiving means is located a second distance from the centerline, and the first distance is greater than the second distance.

[0008] One object of the present invention is to provide a unique internal combustion engine piston.

[0009] Related objects and advantages of the present invention will be apparent from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is an illustrative view of a portion of a vehicle including an internal combustion engine.

[0011] FIG. 2 is an illustrative sectional view of a portion of the engine of FIG. 1 showing a piston comprising one form of the present invention.

[0012] FIG. 3 is a view of the piston of FIG. 2 removed from the engine.

[0013] FIG. 4 is a view illustrating the movement of fuel within the bowl comprising a portion of the piston of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0014] For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

[0015] With reference to FIG. 1, there is illustrated a portion of a vehicle 20 including an internal combustion engine 40. While the internal combustion engine 40 has broad application in vehicles the present invention also contemplates the utilization of the engine 40 in non-vehicular applications such as, but not limited to: stationary power plants, generator sets, auxiliary power systems, industrial stationary equipment, marine propulsion. In a preferred form of the present invention the internal combustion engine 40 is a compression ignition (diesel) internal combustion engine. However, gasoline, spark ignition and other types of internal combustion engines are contemplated herein. The reciprocating piston internal combustion engine 40 includes an engine block and at least one combustion chamber. Of course, the engine may contain a plurality of combustion chambers, typically four to eight, which may be arranged in line or in a "V" configuration. In a preferred form of the present invention the engine contains a plurality of combustion chambers.

[0016] With reference to FIG. 2, there is illustrated a portion of engine 40 including the cylinder block 21, piston 22 and cylinder head 23. In a preferred form the cylinder head 23 is removable and a gasket 30 is disposed between the cylinder head 23 and the engine block 21. Further, the piston 22 has been illustrated within the cylinder cavity 25 with the rings removed. Although not specifically illustrated,

the piston **22** is connected through a connecting rod to the crankshaft of the internal combustion engine. The internal combustion engine causes the piston **22** to reciprocate along a rectilinear path within the cylinder cavity **25**. A combustion chamber **24** is formed at end of the cylinder cavity **25** and is bounded by the cylinder head **23** and the top surface of the piston **22**. A fuel injector nozzle **26** injects fuel into the combustion chamber. In a preferred form of the present invention the fuel injector nozzle **26** delivers a plume of fuel to a portion **27** of the piston **22** the discharge of the fuel. The present invention contemplates variations in the engine, including, but not limited to, other fuel injection systems, combustion chamber shapes, number and location of valves, and cylinder cavities having a removable cylinder liner.

[0017] With reference to **FIG. 3**, there is illustrated the piston **22** removed from the cylinder cavity **25** of the internal combustion engine **40**. In one form the piston is an integral metallic structure formed of a heat resistant alloy. However, the present application contemplates that the piston could be of a variety of other styles, including, but not limited to, an articulated piston, monobloc piston, forged piston, multi-piece piston, and other configurations known to those of skill in the art. The piston may be formed of a metallic, inter-metallic, ceramic, and/or composite material. The material is preferably selected to withstand the normal temperatures and pressures associated with an internal combustion engine combustion chamber. The illustrated piston **22** includes a head **52** having a crown **53** and a piston skirt **54** extending from the head **52**. However, depending on the type of piston configuration, there may be some differences in the basic structure of the piston. The piston further includes a plurality of piston ring grooves **100**, **101** and **102** for receiving piston rings therein (not illustrated). The location and number of ring grooves **100**, **101** and **102** are not meant to be limiting, and pistons having other numbers and locations of ring grooves are contemplated herein.

[0018] The upper surface **50** of piston **22** is provided with a cavity **51**, which will generally be referred to as a combustion bowl. More specifically, the combustion bowl **51** is formed in the piston **22** and extends downwardly from the crown **53** to a bottom wall. The bottom wall has been illustrated as having a substantially Mexican-hat shape. However, other geometric shapes are contemplated herein including, but not limited to round, no-apex, or highly reentrable bowls. In a preferred form the combustion bowl **51** is symmetrical about a centerline X and has a substantially circular shape. A portion **27** of the piston defines a rounded lip extending circumferentially along an intermediate location of the combustion bowl **51**. In one form of the portion **27** overlays a portion of the region **103** of the bowl **51**. An upwardly flared outer bowl section **60** is formed in the piston adjacent to the rounded lip **27** and extends toward the substantially sharp lip portion **61**. The sharp lip portion **61** extends along the circumference of the combustion bowl **51** adjacent the top surface **50**. In one form the sharp lip portion **61** includes an upstanding wall **62** that extends from the sharp lip portion **61** towards the upwardly flared outer bowl section **60**. The sharp lip portion **61** includes a sharp edge **75** defined at the junction between the top surface **50** of the piston and the upstanding wall **62**. In one embodiment the upstanding wall **62** extends about 1 millimeter from the top surface **50** of the piston. In a more preferred form of the invention the upstanding wall **62** is substantially parallel to the centerline X. In one embodiment a radius **70** transitions

from the upstanding wall **62** to the upwardly flared outer bowl section **60**. The diameter of the combustion bowl **51** at the sharp lip portion **61** is represented by arrow 'B' and the diameter of the combustion bowl at the rounded lip portion **27** is represented by arrow 'L'. In one form of the present invention the diameter 'B' is about 70 millimeters and the diameter 'L' is about 56.5 millimeters. In one form the piston **22** has a diameter within the range of about 3 inches to about 6 inches, and more preferably has a diameter of about 4 inches. However, pistons having other sizes are contemplated herein unless specifically provided to the contrary. Further, other lengths and sizes are also contemplated herein.

[0019] The structure of the piston **22** has been set forth above with the aid of **FIGS. 2 and 3**. With reference to **FIG. 4**, there is illustrated one application wherein the fuel plume **80** from the injector is targeted at the circumferential rounded lip **27** in the combustion bowl **51**. A portion of the fuel plume **80** runs up the upwardly flared outer bowl section **60** and hits the sharp lip portion **61** at the top surface **50** of the piston. This configuration directs the portion of the spray plume from the combustion bowl **51** up into the combustion chamber **24** in the general direction of arrow 'Y'. It has been found that the present invention prevents the spray plume from spilling over onto the top surface **50** of the piston and running up against the cylinder cavity wall **90**. Thereby reducing the discharge of black smoke and/or particulate emissions and minimizing the passage of fuel and/or soot into the engine oil.

[0020] While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected. It should be understood that while the use of the word preferable, preferably or preferred in the description above indicates that the feature so described may be more desirable, it nonetheless may not be necessary and embodiments lacking the same may be contemplated as within the scope of the invention, that scope being defined only by the claims that follow. In reading the claims it is intended that when words such as "a," "an," "at least one," "at least a portion" are used there is no intention to limit the claim to only one item unless specifically stated to the contrary in the claim. Further, when the language "at least a portion" and/or "a portion" is used the item may include a portion and/or the entire item unless specifically stated to the contrary.

What is claimed is:

1. An apparatus, comprising:

a piston having a longitudinal centerline and a first end, said piston having a circumferential sidewall portion and a bottom wall portion defining a combustion bowl within said piston at said first end, said sidewall portion including a sharp edge at said first end of the piston and a substantially rounded lip spaced axially from said sharp edge, wherein the combustion bowl defined at said sharp edge is round and said rounded lip is closer to said centerline than said sharp edge is to said centerline.

2. The apparatus of claim 1, wherein said first end has an annular surface and said sharp edge limits a fuel from passing out of said combustion bowl and onto said annular surface.

3. The apparatus of claim 1, wherein said first end has an annular surface and said sharp edge limits a fuel from passing out of said combustion bowl and across said annular surface.

4. The apparatus of claim 1, wherein said substantially rounded lip is located between said bottom wall portion and said sharp edge, and wherein said substantially rounded lip overhanging a portion of said combustion bowl.

5. The apparatus of claim 1, wherein said sidewall portion including an upwardly flared portion located between said sharp edge portion and said rounded lip portion.

6. The apparatus of claim 5, wherein said sidewall portion including an upstanding wall portion located between said sharp edge and said upwardly flared portion.

7. The apparatus of claim 6, wherein said upstanding wall portion is substantially parallel with said longitudinal centerline.

8. The apparatus of claim 1 wherein said combustion bowl is substantially symmetrical about said longitudinal centerline;

wherein said substantially rounded lip is located between said bottom wall portion and said sharp edge, and wherein said substantially rounded lip overhanging a portion of said combustion bowl; and

wherein said sidewall portion including an upwardly flared portion located between said sharp edge portion and said rounded lip portion.

9. The apparatus of claim 9, wherein said sidewall portion including an upstanding wall portion located between said sharp edge and said upwardly flared portion.

10. The apparatus of claim 9, wherein said first end has an outer annular surface and said sharp edge limits a fuel from passing out of said combustion bowl and onto said annular surface.

11. The apparatus of claim 1, wherein said piston is formed of a material that can withstand the temperatures and pressures associated with a combustion chamber of an internal combustion engine.

12. The apparatus of claim 1, wherein said combustion bowl is substantially symmetrical about said longitudinal centerline;

wherein said substantially rounded lip is located between said bottom wall portion and said sharp edge, and wherein said substantially rounded lip overhanging a portion of said combustion bowl;

wherein said sidewall portion including an upwardly flared portion located between said sharp edge portion and said rounded lip portion;

wherein said sidewall portion including an upstanding wall portion located between said sharp edge and said upwardly flared portion; and

wherein said first end has an outer annular surface and said sharp edge limits a fuel from passing out of said combustion bowl and along said annular surface.

13. The apparatus of claim 12, wherein said piston is formed of a material that can normally withstand the temperatures and pressures associated with a combustion chamber of an internal combustion engine.

14. An apparatus, comprising:

a piston body having a longitudinal centerline and a first end surface, said piston body having a combustion bowl defined therein with an entrance adjacent said first end surface, said piston body having a sharp edge portion at said entrance for directing a fuel exiting said combustion bowl away from said first end surface and a rounded portion for receiving a fuel thereon within said combustion bowl, said rounded portion is located closer to said longitudinal centerline than said sharp edge portion is located to said centerline and wherein said entrance is round.

15. The apparatus of claim 14, wherein said piston body has an outer circumferential surface, and wherein said sharp edge portion is located radially inward of said outer circumferential surface; and wherein said combustion bowl is symmetrical about said longitudinal centerline.

16. The apparatus of claim 14, wherein said sharp edge portion directing the fuel exiting the combustion bowl in a direction approximately parallel with said centerline.

17. The apparatus of claim 14, wherein said rounded portion and said sharp edge portion extending circumferentially around said combustion bowl.

18. The apparatus of claim 17, wherein said piston body having a bottom surface defining a portion of said combustion bowl, and wherein said rounded portion is located between said bottom surface and said sharp edge portion.

19. The apparatus of claim 18, wherein said piston body having an upwardly flared portion defining a portion of said combustion bowl, and wherein said upwardly flared portion is located between said rounded portion and said sharp edge portion.

20. The apparatus of claim 14, wherein said piston body has an outer circumferential surface; wherein said sharp edge portion is located radially inward to said outer circumferential surface; wherein said combustion bowl is symmetrical about said longitudinal centerline, wherein said piston body having a bottom surface defining a portion of said combustion bowl, and wherein said rounded portion is located between said bottom surface and said sharp edge portion; wherein said piston body having an upwardly flared portion defining a portion of said combustion bowl, and wherein said upwardly flared portion is located between said rounded portion and said sharp edge portion; and wherein said rounded portion, said sharp edge portion and said upwardly flared portion extend circumferentially around said bowl.

21. The apparatus of claim 20, wherein said piston is formed of a material that can withstand the temperatures and pressures associated with a combustion chamber of an internal combustion engine.

22. An apparatus, comprising:

a piston body having a longitudinal centerline and a first end, said piston body having a circumferential sidewall portion and a bottom wall portion defining a combustion bowl within said piston, said combustion bowl having a substantially round entrance at said first end, said sidewall portion including fuel directing means at said entrance for directing a fuel leaving said combustion

tion bowl away from said first end and fuel receiving means for receiving a fuel within said combustion bowl, wherein said fuel directing means is located a first distance from said centerline and said fuel receiving means is located a second distance from said centerline, and wherein said first distance is greater than said second distance.

23. The apparatus of claim 22, wherein at least a portion of said fuel receiving means overhanging a portion of said combustion bowl;

wherein said combustion bowl is symmetrical about said longitudinal centerline;

wherein said piston body includes a flared portion between said fuel directing means and said fuel receiving means.

24. The apparatus of claim 23, wherein said fuel directing means, said fuel receiving means and said flared portion extending circumferentially around said combustion bowl.

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