US006955154B1

(12) **United States Patent**
Douglas

(10) **Patent No.: US 6,955,154 B1**
(45) **Date of Patent: Oct. 18, 2005**

(54) **FUEL INJECTOR SPARK PLUG**

(76) Inventor: **Denis Douglas**, P.O. Box 344, Soldotna, AK (US) 99669

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/926,927**

(22) Filed: **Aug. 26, 2004**

(51) **Int. Cl.**[7] **F02M 57/06**
(52) **U.S. Cl.** **123/297**; 313/120; 313/139
(58) **Field of Search** 123/151, 152, 123/297; 239/585.1, 585.5; 313/120, 139

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,333,897 A * 3/1920 Bringman 313/120
3,665,902 A * 5/1972 Bloomfield 123/297
RE29,978 E * 5/1979 Leshner et al. 123/297
5,497,744 A * 3/1996 Nagaosa et al. 123/297
5,531,199 A * 7/1996 Bryant et al. 123/297
6,536,405 B1 * 3/2003 Rieger et al. 313/120
2003/0111042 A1 * 6/2003 Rieger et al. 123/297

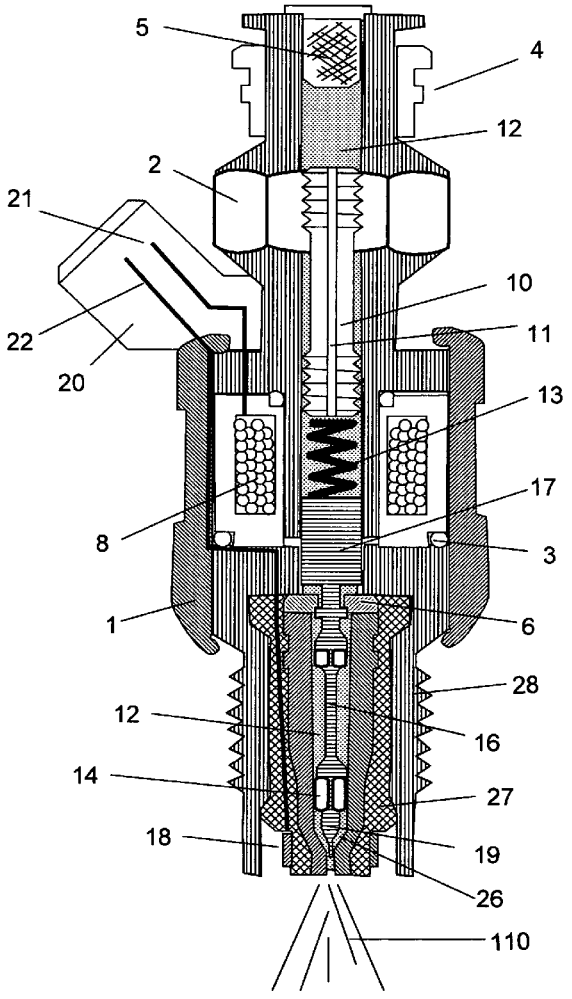
* cited by examiner

Primary Examiner—Erick Solis
(74) *Attorney, Agent, or Firm*—Michael J. Tavella

(57) **ABSTRACT**

A spark plug and fuel injector combination. The spark plug has a central channel that funnels fuel into the lower portion of the spark plug, where it is superheated. A solenoid system causes a needle valve to rise up to allow a measured quantity of fuel to be injected into a cylinder through a nozzle, where it vaporizes upon exiting the spark plug. A spring releases the needle valve to close the nozzle. The spark plug also has an ignition ring on the base. The ignition ring produces an encompassing spark, which produces complete combustion of the vaporized fuel. This produces more power and better fuel economy.

12 Claims, 6 Drawing Sheets



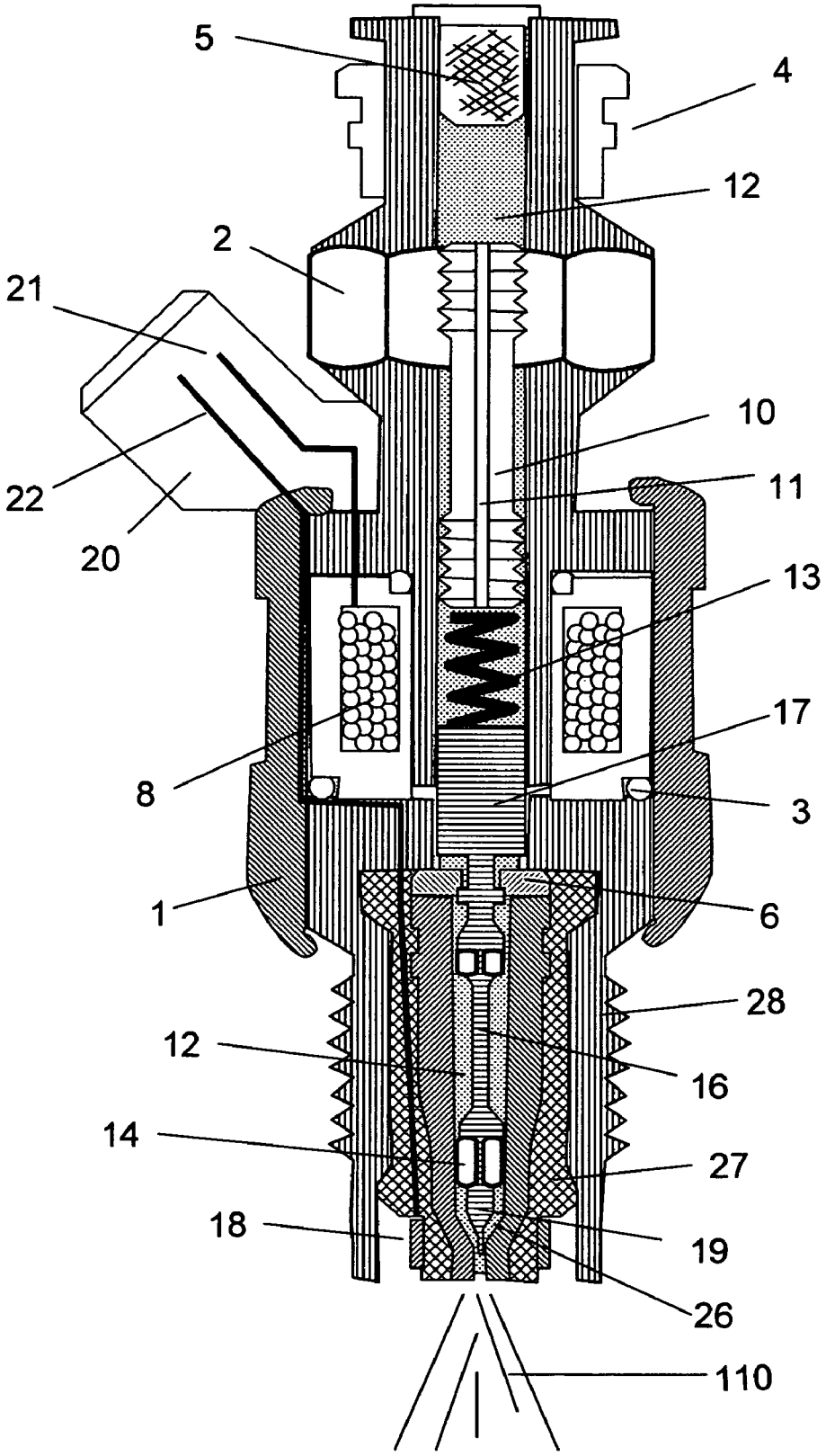


Figure 1

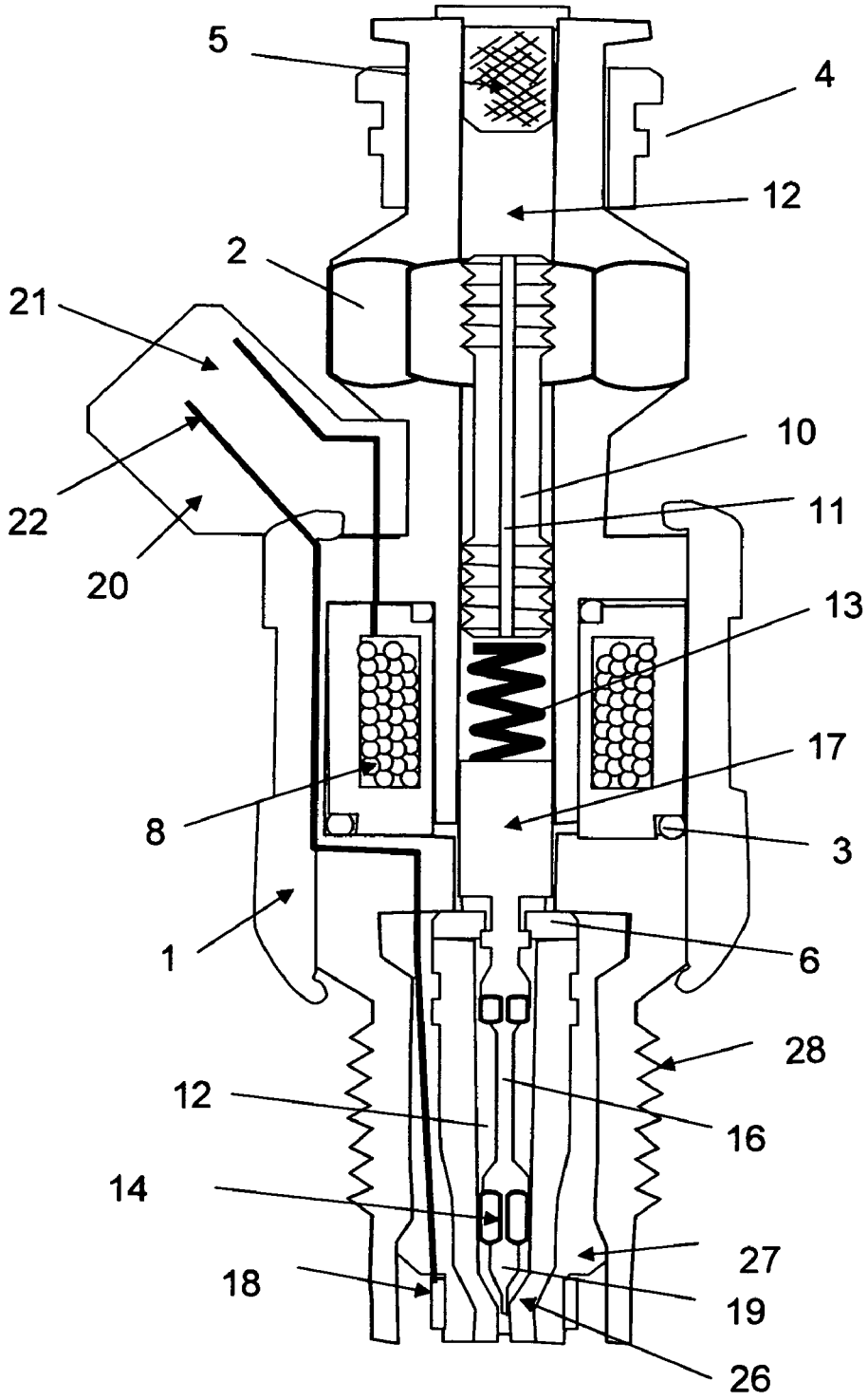


Figure 2

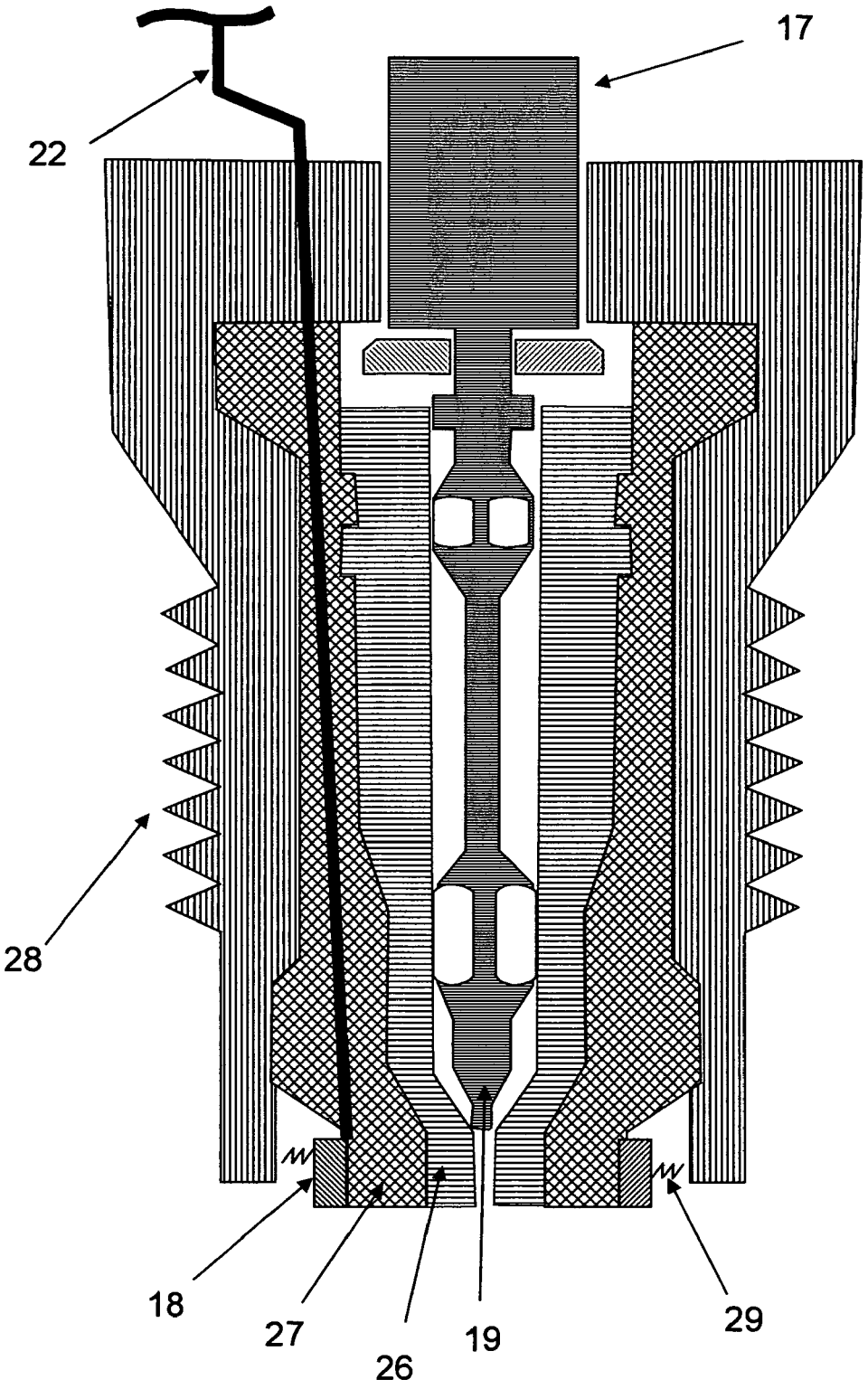


FIGURE 3

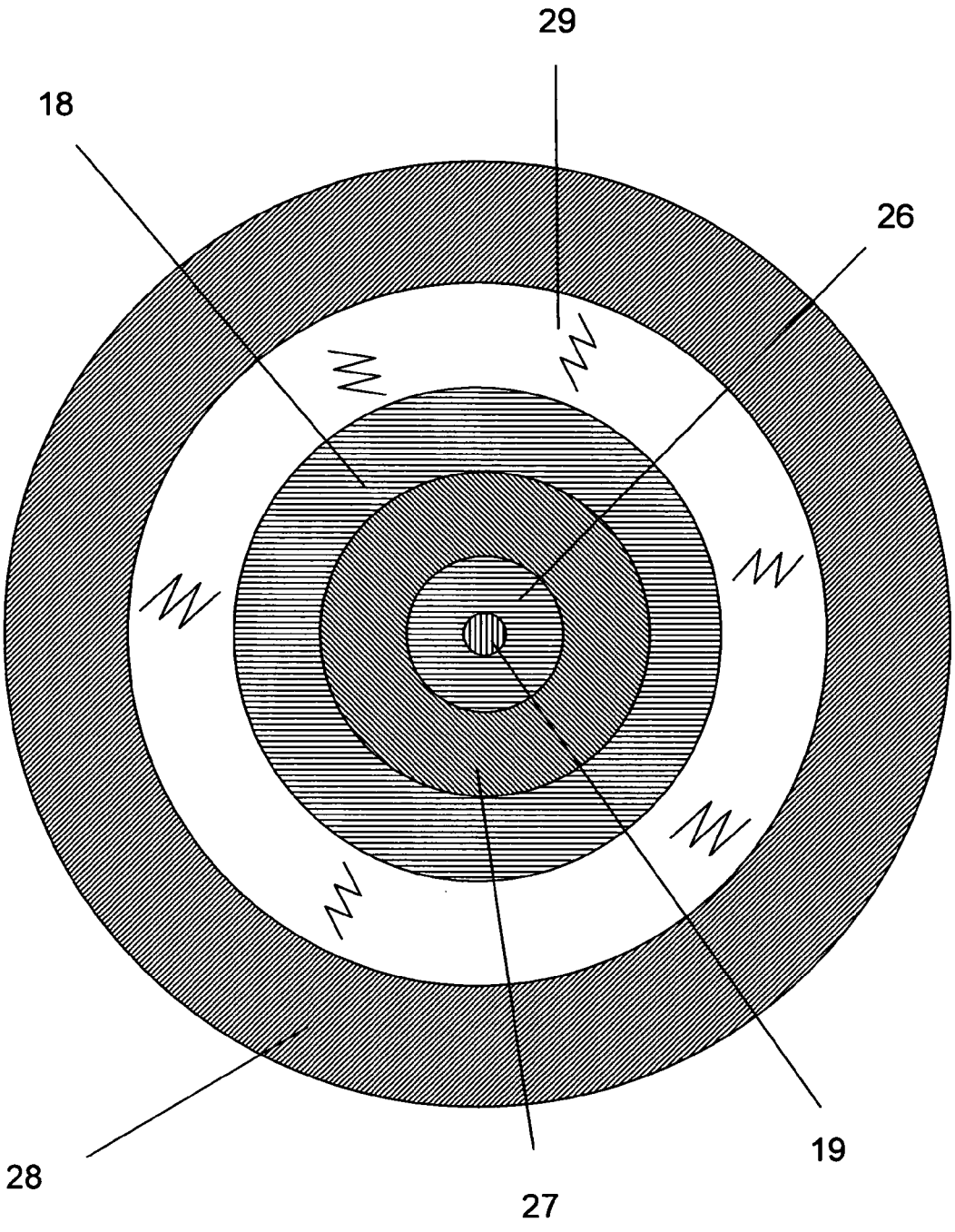


FIGURE 4

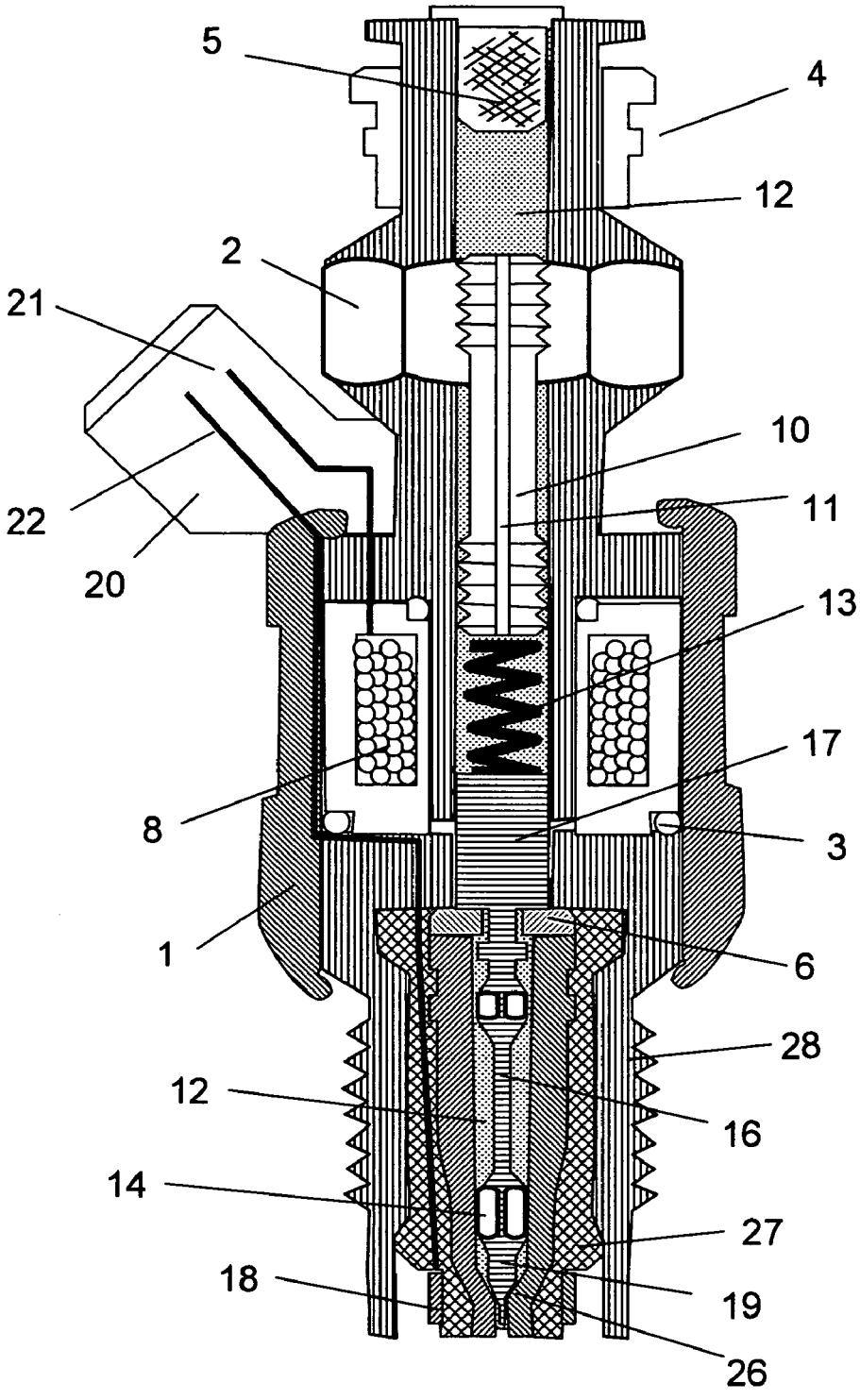


Figure 5

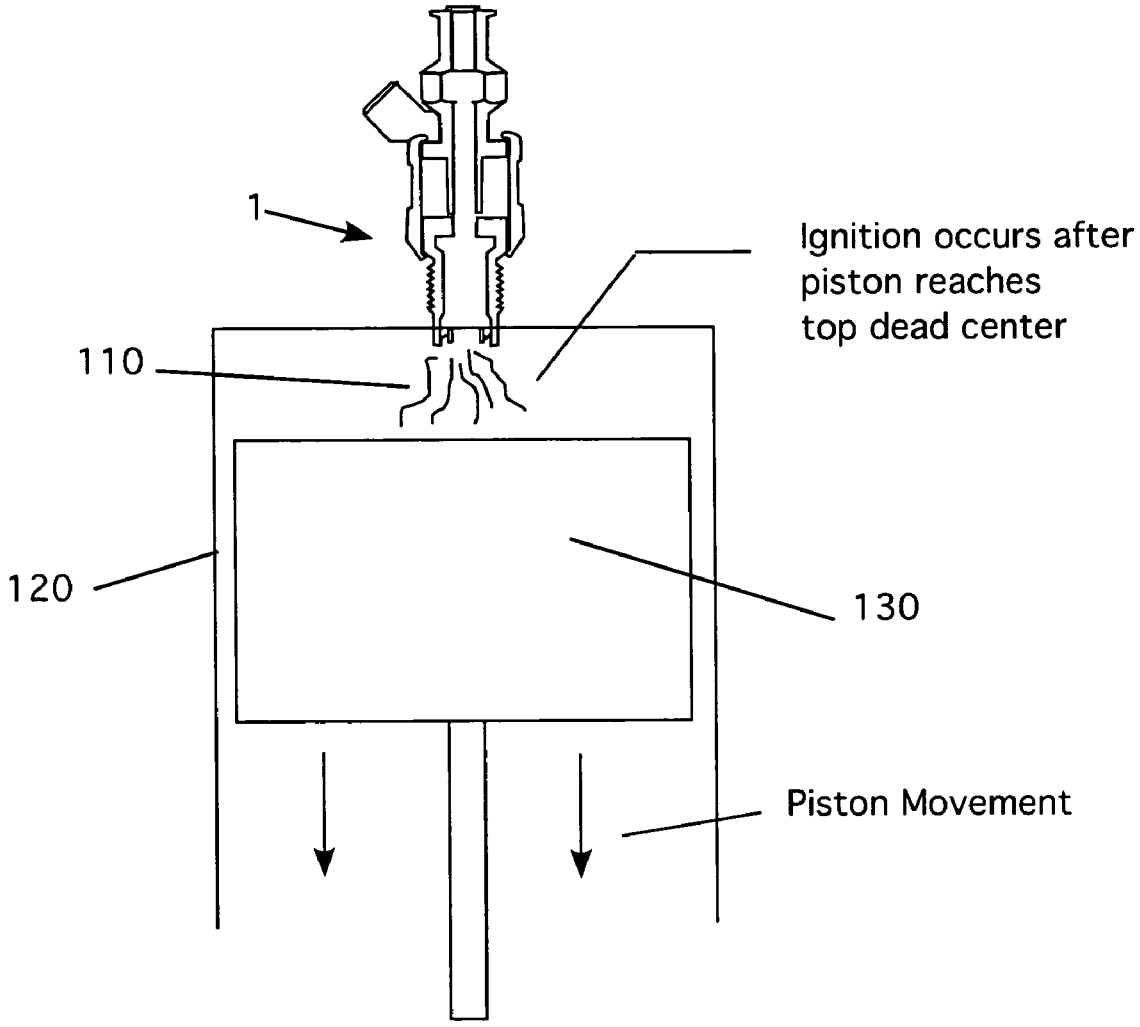

1
Ignition occurs after piston reaches top dead center
110
120
130
Piston Movement

Figure 6

FUEL INJECTOR SPARK PLUG

CROSS REFERENCE TO RELATED APPLICATIONS

Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

Not Applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to fuel injector spark plugs and particularly to fuel injector spark plugs that vaporize fuel prior to injection.

2. Description of the Prior Art

Spark plugs and fuel injectors have been used in internal combustion engines since the inception of such engines. In recent years, almost all engines use fuel injection in combination with traditional spark plugs in gasoline engines. Although this is a good combination, there are some inefficiencies in delivering the fuel to the cylinder separately from the spark plug. By injecting the fuel right at the source of the spark, it is possible to enhance the power generated and to burn the fuel more completely. To that end, several spark plug-injector patents have been issued. Examples of these are found in U.S. Pat. Nos. 1,310,970, 2,795,214, 3,173,409, 4,095,580, 5,497,744, 4,736,718, and 6,536,405.

In the past, it appears that engine damage was encountered because fuel was inadvertently vaporizing in the cylinder (manifold), ?? thereby causing too much pressure (power). As a result, additives were used to counter the problem.

BRIEF DESCRIPTION OF THE INVENTION

The instant invention is designed to overcome the problem of inadvertent or premature vaporization of fuel. Thus, the intent of the invention is to utilize vaporized fuels in engines currently being used because vaporized fuels produce a superior energy release.

The invention consists of a spark plug and fuel injector combination. The spark plug has a central channel that funnels fuel into the lower portion of the spark plug, where it is vaporized. A solenoid system causes a needle valve to rise up to allow a measured quantity of fuel to be injected into a cylinder through a nozzle. A spring releases the needle valve to close the nozzle. The spark plug also has an ignition ring on the base. The ignition ring produces an encompassing spark, which produces complete combustion of the vaporized fuel. This produces more power and better fuel economy.

It is an object of this invention to produce a fuel injector spark plug that creates and maintains an environment hospitable for vaporized fuels in a compression chamber.

It is another object of this invention to produce a fuel injector spark plug that delivers fuel vapor to cylinder directly to maintain the fuel in vapor form.

It is yet another object of this invention to produce a fuel injector spark plug that eliminates excess fuel use thereby eliminating excess heat.

It is a further object of this invention to produce a fuel injector spark plug that increases mileage and power.

It is a further object of this invention to produce a fuel injector spark plug that saves energy.

It is a further object of this invention to produce a fuel injector spark plug that allows all additives that restrict vaporization to be removed from fuel.

It is a further object of this invention to produce a fuel injector spark plug that allows all additives that are harmful to the environment to be removed from fuel.

It is a further object of this invention to produce a fuel injector spark plug that greatly simplifies engine components accessories, and operation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of the invention.

FIG. **2** is a cross sectional view of the invention showing the placement of the electrical leads.

FIG. **3** is a cross-sectional view of the lower portion of the invention showing the fuel needle and ignition ring.

FIG. **4** is a detail of the ignition ring.

FIG. **5** is a bottom view of the invention showing the ignition ring.

FIG. **6** is a detail view of an internal combustion cylinder showing the invention igniting after the piston reaches top dead center.

DETAILED DESCRIPTION OF THE INVENTION

The instant invention is a spark plug-fuel injector that is designed to vaporize fuel and deliver it into a cylinder and ten ignite it to produce a highly efficient burn. As a result, some changes on engine operation are required. For example, due to the increased speed and efficiency of the fuel burn, the engine timing must change. In most gasoline engines, ignition occurs while the piston is still traveling upward. That means counter opposing force is being applied. The reason for this is that atomized fuel requires a certain amount of time to burn. If the engine timing is advanced, combustion occurs outside the combustion chamber and manifests itself as a backfire through the intake manifold. Moreover, if the timing is retarded, combustion is noted outside the combustion chamber in the form of a backfire into the exhaust manifold.

Using the instant invention, however, vaporized gasoline has far better burn characteristics. It allows timing changes that eliminate the counter opposing forces in the engine, which cause it to take on some of the advantageous features of a rotary engine.

Vaporized gasoline condenses when exposed to ambient air. Thus, it must remain vaporized throughout the combustion process to maintain its highly flammable state. That means it must be introduced to an environment with a high enough temperature to keep the fuel from condensing. The instant invention accomplishes this by injecting super heated fuel, under high pressure, into the compression chamber just as the piston starts its downward motion, and then immediately igniting it.

Referring now to FIG. **1**, a cross-section of the injector spark plug **100** is shown. The plug has an outer shell **1**. At the top of the plug is a formed portion that includes a hex nut portion **2**. The center of the plug is hollow to accommodate a quantity of fuel. At the top of the hex nut portion **2** is an inlet port **4** for a fuel line, which has a screen **5** to filter the fuel. The hex nut portion **2** extends down to a middle portion **6** as shown. An outer shell **1** is used to join the hex nut portion **2** with a threaded lower portion **28**, discussed below.

An O-ring **3** is used to make a seal. A solenoid coil **8** is placed about the center of the spark plug as shown. Below the solenoid coil **8**, is a lower portion **28**, which contains the fuel needle **16**, ignition ring **18** and a porcelain insulator **27** (see FIGS. **2** and **3**).

The hollow center portion acts as a fuel conduit. A flow restrictor **10** is placed in the hollow center as shown. A fuel passage **11** is formed in the center of the flow restrictor **10** as shown. This passage allows fuel **12** to run down the center of the spark plug to the lower portion of the plug. A needle **16** is used as a valve to hold the fuel in the plug until is it ready for use. A spring **13** is positioned below the flow restrictor as shown. The fuel needle **16** is positioned below the spring as shown. To top **17** of the needle **16** acts as a plunger that contacts the spring **13**.

In operation, the lower portion, as discussed below, is designed to hold the needle in position to allow it to move up and down within the spark plug. The top of the needle **17** is made of a ferric metal that is controlled by the solenoid, as discussed below.

On one side of the spark plug is an electrical connector plug **20**. This plug is designed to bring electric power into the spark plug. One conductor **21** brings positive power to the solenoid (the solenoid impulse conductor). Another conductor **22** brings power to the ignition ring **18**. The solenoid impulse conductor sends power to the solenoid, which, when energized, pulls the plunger **17** upwards (as shown in FIG. **1**). This action lifts the needle upward, which open the tip **15** of the plug, which in turn, allows a measured quantity of fuel **110** to exit the tip **15**. Note that in the preferred embodiment, the needle **16** has flattened surfaces **14** that permit the fuel to flow down past the needle. The operation of the solenoid (which generates heat) and the pressure in the plug creates a situation where the fuel exiting the spark plug is a super heated liquid. This superheated fuel immediately vaporizes upon leaving the tip of the plug. This is discussed further below.

The travel of the needle (and plunger) is controlled by the spring **13***m* which causes to needle to be pushed down when the solenoid is de-energized and by a needle valve controller ring **6**, which limits the upward travel of the needle **16** as well as the downward travel of the plunger **17** see FIG. **3**.

FIG. **2** is a cross-section of the device **1** that more clearly shows the routing of the conductors **21** and **22**.

FIG. **3** shows details of the lower portion. Here, the fuel needle **16** is in the "closed" positioned. This figure shows the collar **6** that is designed to hold the needle in position to allow it to move up and down within the spark plug. As mentioned above, the top of the needle **17** is a Ferris metal plug is shown. The lower portion of the needle **16** has a tip **19** that seats in a tapered nozzle **26**. The ignition ring **18** is also shown in this figure. The action of the ignition ring is discussed below. Note that an insulator **27** is positioned between the ignition ring **18** and the nozzle **26**. This insulation prevents flashover inward toward the nozzle. The threaded outer portion **28** of the lower portion of the spark plug is connected to ground to receive the spark **29** when power is sent to the ignition ring. Here, conductor **22** is shown extending down through the body of the plug.

FIG. **4** shows the ring **18**, the insulator **27**, the outer portion **28** and the spark **29** from the bottom of the plug. As is clear in this figure, the ring **18** completely surrounds the center of the plug. Moreover, the outer portion **28** also is a continuous ring. This allows the spark **29** to provide complete ignition of the fuel in as efficient a manner as possible.

FIG. **5** shows a cross-section of the device similar to that of FIG. **1**, except that here, fuel **12** is shown in the lower portion and the needle valve is in the closed position.

FIG. **6** is a detail view of an internal combustion cylinder **120** showing the invention **100** igniting after the piston **130** reaches top dead center. In operation, plug is full of superheated fuel as the piston **130** is rising in the cylinder **120**. Just past top dead center, as the piston **130** begins its downward motion, the solenoid **8** caused the needle **16** to lift, which causes a quantity of fuel **110** to squirt into the cylinder **120**, where it vaporizes immediately. Immediately after, a charge is sent to the ignition ring **18**, which produces a spark **29** that ignites the fuel **110**. Because the piston **130** is already in a downward motion, the firing of the fuel produces a power boost that provides more power to the stroke.

In a conventional engine, sufficient time is needed to allow the fuel to fully burn and produce energy. To accomplish this, the fuel is ignited while the piston is still rising in the cylinder. This procedure is not as efficient as it could be. Ideally, the piston should be moving down upon ignition, as in the case of the instant invention.

The present disclosure should not be construed in any limited sense other than that limited by the scope of the claims having regard to the teachings herein and the prior art being apparent with the preferred form of the invention disclosed herein and which reveals details of structure of a preferred form necessary for a better understanding of the invention and may be subject to change by skilled persons within the scope of the invention without departing from the concept thereof.

I claim:

1. An integrated fuel injector-spark plug for injecting fuel directly into a combustion chamber of an internal combustion engine and for igniting the fuel that is injected into the combustion chamber, comprising:

a) a housing, having a bottom and a hollow core, and an outlet nozzle;

b) a needle valve, operably installed in said hollow core, such that when said needle valve is in a closed position, said needle valve seals said outlet nozzle;

c) a means for operating said needle valve;

d) an ignition ring, installed on the bottom of said housing, surrounding said outlet nozzle;

e) an insulating medium, positioned between said ignition ring and said outlet nozzle; and

f) a grounding means, attached to said housing to attract an electrical charge from said ignition ring, thereby causing a spark ring about said bottom of said housing.

2. The integrated fuel injector-spark plug of claim **1** wherein the means for operating said needle valve comprises a solenoid.

3. The integrated fuel injector-spark plug of claim **1** wherein the spark is created on a timed control basis.

4. The integrated fuel injector-spark plug of claim **3** wherein the timed control basis is in coordination with the movement of a piston in a cylinder having a top dead center.

5. The integrated fuel injector-spark plug of claim **4** wherein the spark occurs after the piston has moved past top dead center.

6. An integrated fuel injector-spark plug for injecting fuel directly into a combustion chamber of an internal combustion engine and for igniting the fuel that is injected into the combustion chamber, comprising:

a) a housing, having a bottom and a hollow core, and an outlet nozzle;

b) a needle valve, operably installed in said hollow core, such that when said needle valve is in a closed position, said needle valve seals said outlet nozzle;

c) a means for operating said needle valve;

d) an ignition ring, installed on the bottom of said housing, surrounding said outlet nozzle;

e) an insulating medium, positioned between said ignition ring and said outlet nozzle; and

f) a grounding means, attached to said housing to attract an electrical charge from said ignition ring, thereby causing a spark ring about said bottom of said housing;

g) wherein, a quantity of fuel being held in said hollow core is superheated within said housing before being dispensed.

7. The integrated fuel injector-spark plug of claim **6** wherein the means for operating said needle valve comprises a solenoid.

8. The integrated fuel injector-spark plug of claim **6** wherein the spark is created on a timed control basis.

9. The integrated fuel injector-spark plug of claim **8** wherein the timed control basis is in coordination with the movement of a piston in a cylinder having a top dead center.

10. The integrated fuel injector-spark plug of claim **9** wherein the spark occurs after the piston has moved past top dead center.

11. The integrated fuel injector-spark plug of claim **8** wherein a quantity of fuel being held in said housing is dispensed on a timed control basis.

12. The integrated fuel injector-spark plug of claim **8**, wherein the quantity of fuel being is vaporized upon being dispensed from said housing.

* * * * *