

- [54] **SPARK PLUG WITH GLOW PLUG**
[75] Inventor: **Sam J. Green**, Temperance, Mich.
[73] Assignee: **Champion Spark Plug Company**,
Toledo, Ohio
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3,589,348 6/1971 Reichhelm 123/169 PB
3,680,538 8/1972 Scherenberg 123/169 PB

Primary Examiner—Charles J. Myhre
Assistant Examiner—James W. Cranson
Attorney, Agent, or Firm—Owen & Owen

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169 R

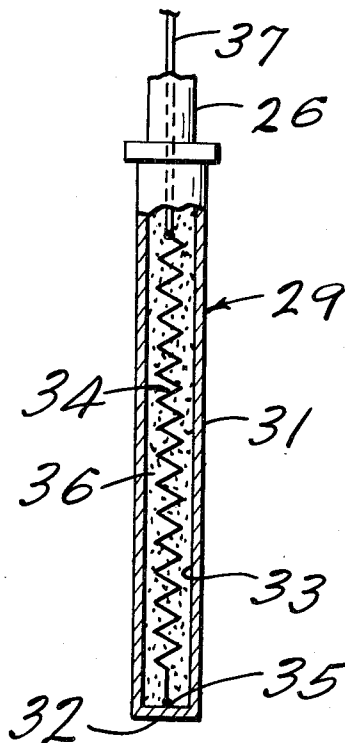
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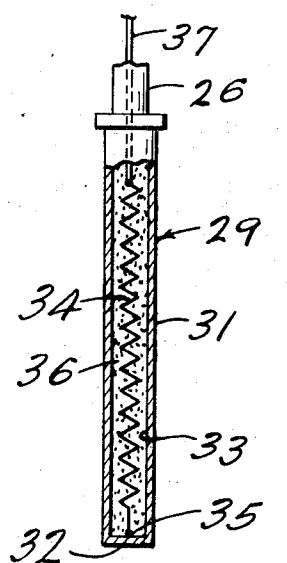
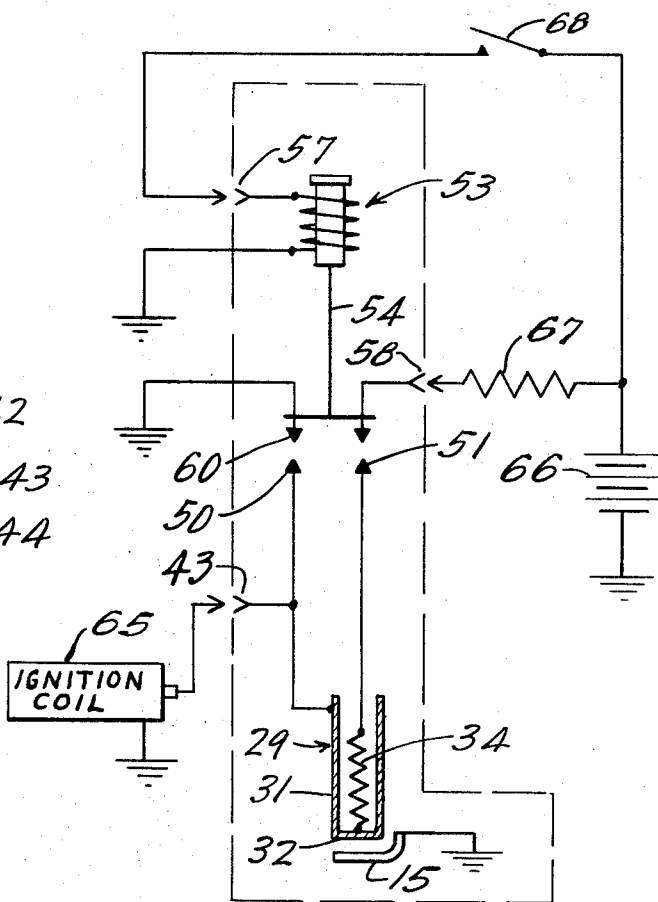
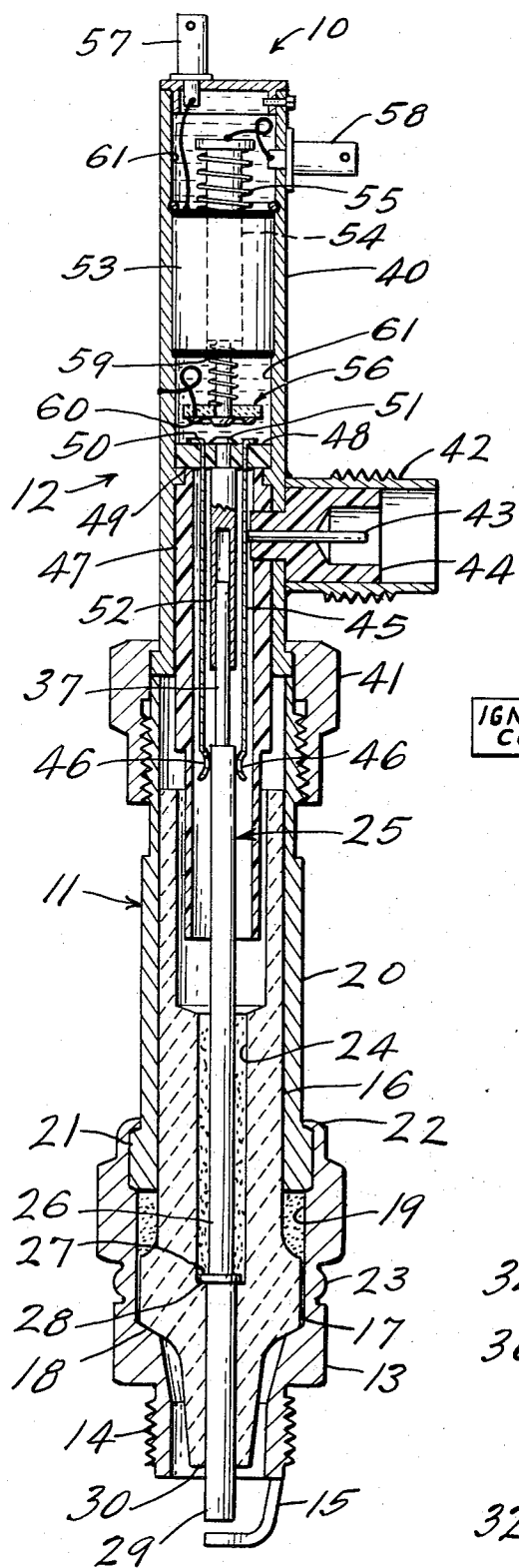
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[57] **ABSTRACT**

An ignition device for an internal combustion engine which serves as both a spark plug during normal running of the engine and a heater for warm-up of the combustion chamber prior to starting the engine. An electric heater is located within a chamber in the tip portion of the center electrode of a spark plug. Prior to starting the engine, a solenoid switch may be actuated to ground the center electrode tip and, simultaneously, to apply power to the heater for engine warm-up. When the solenoid switch is released, the ignition device functions as a conventional spark plug for igniting fuel in a combustion chamber.

6 Claims, 3 Drawing Figures





SPARK PLUG WITH GLOW PLUG

BACKGROUND OF THE INVENTION

This invention relates to ignition devices and more particularly to an improved spark plug for an internal combustion engine which includes means for preheating the engine combustion chamber prior to starting the engine.

Under different environmental conditions, internal combustion engines require different fuel compositions for ease in starting and efficiency in operation. If, for example, an engine is to be operated in a very warm climate, the engine will readily start with a relatively low volatility fuel. Such fuels are required to minimize fuel losses through evaporation. If the same engine is to be operated under extreme cold or arctic conditions, a much more volatile fuel will normally be required to start the engine. This difference in fuel requirements can present problems, particularly with military engines which may be operated in adverse environments. Ideally, the military should have engines which will start and operate under either extremely cold or extremely hot conditions with a single fuel composition.

Under certain conditions, internal combustion engines may be difficult to start. If an engine is, for example, at a temperature of perhaps 30°F. to 35°F., moisture may condense on the spark plug and on the cool walls of the combustion chamber. Such moisture, particularly when combined with normal deposits on the spark plug, can effectively short circuit the spark plug. In extremely cold weather, moisture may freeze onto the spark plug, also causing a short circuit.

Raw fuel can also accumulate on a spark plug to form an effective short circuit. In fuel injected engines, extremely cold weather may cause the injected fuel to be only partially atomized. Until the engine is heated, the fuel may condense or collect on the cold spark plug and cylinder walls. Cold starting problems of this type are further increased when the engine is in a poor state of tune. Furthermore, in extremely cold weather, there is generally a decrease in the available voltage caused by a voltage drop due to both a decrease in the maximum battery output and an increased load placed on the battery when cranking a cold engine.

It has been found desirable in many circumstances to provide means for heating spark plugs prior to starting a cold engine to eliminate moisture, ice and the accumulation of raw fuel which may short circuit the spark plug. At the same time, the combustion chamber may be preheated to facilitate starting. In one type of heated spark plug, an electric heater coil is wound about the nose portion of an insulator which supports a high voltage center electrode. Such an arrangement is shown in, for example, U.S. Pat. No. 1,430,964. In a second type of heated spark plug, as shown in U.S. Pat. No. 3,589,348, an electric heater coil is mounted in a chamber attached to the spark plug shell. The heater is positioned to direct heat towards the insulator nose and the adjacent tip of the center electrode. In each of these embodiments, the heater is subjected to the corrosive and erosive agents present within the engine combustion chamber. An improvement over spark plugs of this type is shown in U.S. Pat. No. 3,680,538. This patent shows a spark plug in which the insulator nose is formed around a heater coil. However, this ar-

range may place unduly high thermal stresses on the insulator which can result in a cracked insulator. It also is more difficult to manufacture the insulator for this spark plug with the heater coil properly located and with terminals for the heater coil. This type of spark plug was designed primarily for preventing the accumulation of deposits on the spark plug insulator when the spark plug is operated in a rotary piston internal combustion engine run at slow speeds.

SUMMARY OF THE INVENTION

According to the present invention, an improved ignition device is provided comprising a spark plug with a heater mounted within the tip of the center electrode to facilitate starting a cold internal combustion engine. The ignition device includes a first or lower portion which, with the exception of the heater, is similar in design to a conventional spark plug. The first portion includes a ceramic insulator mounted within a shell which is threaded to engage the head of an internal combustion engine. A center electrode assembly is mounted within a central bore through the insulator. The center electrode assembly includes a tip which defines a spark gap with a ground electrode attached to the shell. A low voltage electric resistance heater is positioned within a chamber in the center electrode tip for preheating the spark plug and the combustion chamber in the engine prior to starting the engine. A second or upper portion is removably attached to the first portion. The second portion includes a connector for applying high voltage to the center electrode tip and a solenoid operated switch which, when actuated simultaneously grounds the center electrode tip and applies power to the resistance heater in the spark plug tip for preheating the spark plug and combustion chamber prior to starting the engine. The first and second portions of the ignition device may be separated to permit replacement of only the first portion in the event that the center electrode tip and the ground electrode become eroded through use.

Accordingly, it is a preferred object of the invention to provide an improved ignition device for internal combustion engines.

It is a further object of the invention to provide an improved spark plug having means for preheating the spark plug and the associated combustion chamber in an internal combustion engine prior to starting the engine.

Still another object of the invention is to provide an improved ignition device for internal combustion engines comprising a spark plug having means for heating the center electrode tip prior to starting the engine and having an associated switch for selectively energizing such heater.

Other objects and advantages of the invention will become apparent from the following detailed description, with reference being made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of an ignition device constructed in accordance with the principles of the present invention;

FIG. 2 is an enlarged fragmentary view of the tip of the center electrode assembly in the ignition device of FIG. 1; and

FIG. 3 is a schematic circuit diagram showing the electrical operation of the ignition device of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to FIG. 1, an improved ignition device constructed in accordance with the present invention is generally designated by the reference number 10. The ignition device 10 includes a first or lower portion 11 which is similar to a conventional spark plug modified to include a novel heater and a second or upper portion 12 which includes a power control circuit.

The first portion 11 of the ignition device 10 includes a generally tubular-shaped shell 13 having a threaded portion 14 at its lower end for threadably engaging a cylinder head of an internal combustion engine (not shown). A ground electrode 15 is attached to the shell 13 adjacent the threaded portion 14. A ceramic insulator 16 is positioned within the shell 13 such that a radially extending flange 17 on the insulator 16 is seated against an upwardly directed shoulder 18 within the shell 13. A chamber 19 formed above the flange 17 and between the insulator 16 and the shell 13 is filled with a compressible or resilient sealing material, such as talc. A tubular-shaped shield 20 is positioned around the insulator 16 with a radially outwardly extending flange 21 located in the chamber 19. The shell 13 is crimped at 22 over the flange 21 to hold the shell 13, the insulator 16 and the tubular shield 20 together. The shell 13 may then be collapsed in an axial direction at a thin-walled section 23 to place the resilient material in the chamber 19 in a highly compressed state, thereby sealing the shell 13 and the insulator 16 together.

The insulator 16 is provided with a bore 24 in which a center electrode assembly 25 is mounted. The center electrode assembly 25 includes a hollow or tubular member 26 having a radially extending flange 27 which is seated against an upwardly directed shoulder 28 within the insulator bore 24. The electrode member 26 is terminated at a tip 29 which projects from a nose portion 30 at the lower end of the insulator 16. The electrode tip 29 is positioned to define a spark gap with the ground electrode 15 for igniting fuel in a combustion chamber.

Turning to FIGS. 1 and 2, the electrode tip 29 is formed as a continuous piece having a generally tubular wall 31 closed at the bottom by an integral end member 32 to define a chamber 33 which is isolated from the engine combustion chamber. An electrical heater consisting of, for example, a coil of wire 34 is positioned within the chamber 33. A lower end of the heater coil 34 is spot welded or otherwise attached at 35 to the end member 32. A suitable electrical insulating material 36 is packed about the heater coil 34 to insulate the coil 34 from the tubular tip wall 31. A low voltage terminal 37 is connected to the upper end of the heater coil 34 and extends upwardly through the tubular electrode member 26 for supplying power to heat the coil 34 through the Joule effect. When power is supplied through the terminal 37 to the coil 34, heat generated in the coil 34 is conducted to heat the electrode tip 29 and the insulator nose 30. Such heat will evaporate any moisture or ice on the tip 29 and the insulator nose 30 and will also preheat the adjoining combustion chamber within the engine. After the tip 29, the insulator 30 and the combustion chamber are warmed, power is removed from the terminal 37 and a high volt-

age is supplied from an engine ignition system to the tip 29 for igniting fuel within the combustion chamber.

The second or upper portion 12 of the ignition device 10 includes a generally tubular housing 40 which is removably attached to the lower portion 11 by means of a nut 41 which threadably engages the tubular shell 20. A high voltage receptacle 42 is attached to the housing 40 and includes a male terminal 43 mounted within an insulator 44. The receptacle 42 is preferably adapted to receive a standard high voltage plug of a type presently used in existing ignition systems. The terminal 43 is electrically connected to a tubular contact member 45 which is mounted coaxially within the housing 40. The contact member 45 includes an end portion 46 which electrically engages the member 26 of the center electrode assembly 25. The end portion 46 exerts a spring pressure on the member 26 to maintain a good electrical contact. A suitable high voltage insulator 47 is positioned between the contact member 45 and the housing 40. The contact member 45 is attached to a circular insulator 48 which is sealed against an inwardly directed flange 49 formed within the housing 40. Ends or tabs 50 on the contact member 45 are inserted through slots in the insulator 48 and bent over to define electrical contacts, as well as to anchor the contact member 45. An oil-tight seal is provided where the member 49 passes through the insulator 48. A low voltage contact 51 is also attached to the insulator 48 and extends coaxially within the contact member 45. The low voltage contact 51 includes a hollow lower portion 52 adapted to slidably or telescopically receive the low voltage terminal 37 projecting from the first or lower portion 11. The lower portion 52 exerts a spring pressure on the terminal 37 to maintain good electrical contact. Thus, it will be appreciated that the upper portion 12 is, in effect, a coaxial connector adapted to engage the lower portion 11.

Means is provided within the housing 40 for switching power to the center electrode assembly 25 between a high ignition voltage and a low heater voltage. A solenoid 53 is adapted to move a plunger 54 against a return spring 55 to actuate a switch 56. When suitable power is applied between a terminal 57 and the grounded housing 40, the solenoid 53 is energized and the plunger 54 moves to connect a low voltage terminal 58 with the contact 51 to energize the heater coil 34 within the center electrode tip 29. At the same time, a spring 59 biases an annular contact 60 against the ends 50 of the contact member 45 to ground the contact member 45, the connected center electrode member 26 and the electrode tip 29. As a consequence, the ignition device 10 cannot be operated as a spark plug while the heater coil 34 is energized. The solenoid 53 and the insulator 48 are sealed to the housing 40 to define a chamber 61 enclosing the switch 56. The chamber 61 is filled with an insulating oil to prevent flashover between the high voltage circuit and the low voltage circuit. The oil functions primarily as a dielectric barrier.

Turning now to FIG. 3, a schematic circuit diagram is shown for the operation of the ignition device 10. A conventional ignition coil 65 is connected to the terminal 43 within the connector 42 to periodically apply at the proper instance during starting and operating the internal combustion engine a high voltage to the electrode tip 29 for normal spark ignition of fuel in the combustion chamber. A battery 66 is connected

through a ballast resistor 67 to the terminal 58 and also through a heater switch 68 to the solenoid terminal 57. When the heater switch 68 is closed prior to starting the engine, the solenoid 53 is actuated to connect the battery 66 through the ballast resistor 67 and the heater coil 34 to ground, thereby heating the center electrode tip 29, the insulator nose 30 and the adjoining engine combustion chamber. Although only a simple switch 68 is shown in FIG. 3, it will be appreciated that the switch 68 may also include either a timer or a thermal control. An integral timer may be set to close the switch 68 for a predetermined preheat period prior to starting the engine. Or, as an alternative, an integral thermal control may open the switch 68 after either the center electrode tip 29 or the engine combustion chamber is preheated to a predetermined temperature.

From the above description, it will be appreciated that the ignition device 10 consists of two portions, a first portion 11 which functions substantially the same as a conventional spark plug with the addition of an auxiliary heater element 34 within the center electrode tip 29 and a second portion 12 for controlling the application of power to the first portion 11. The device 10 is designed such that it is only necessary to replace the first portion 11 after the ground electrode 15 and the tip 29 have become worn or eroded through extensive use. Furthermore, the device 10 is completely shielded such that it may be readily used in an existing shielded low radio frequency noise ignition system. As previously indicated, a standard high voltage receptacle 42 is used for a high voltage connector so that the device 10 may be inserted in an existing system without changing existing wiring and connectors. Also, the device 10 is designed to minimize capacitive loading of the ignition system when inserted in a pre-existing system. Through such a design, it will be appreciated that an existing ignition system may be converted from a standard spark plug to use with the ignition device 10 with the least amount of down time and the least amount of modification to the existing wiring. It also will be appreciated that various modifications and changes may be made in the above-described preferred embodiment of the ignition device 10 without departing from the spirit and the scope of the claimed invention.

What I claim is:

1. An ignition device for an internal combustion engine comprising, in combination, a generally tubular shell having a threaded portion for attachment to the engine, an electrical insulator having a bore extending therethrough for mounting a center electrode assem-

bly, means mounting said insulator in said shell, a ground electrode, means attaching said ground electrode to said shell adjacent said threaded portion with said ground electrode positioned to be within a combustion chamber in the engine when the device is attached to the engine, a center electrode assembly, means mounting said center electrode assembly in said insulator bore, said center electrode assembly including a tip positioned for defining a spark gap with said ground electrode for spark ignition of fuel in such engine combustion chamber, said tip having an internal chamber, electrical heating means mounted within said tip chamber for preheating such engine combustion chamber prior to starting the engine, and means connected for selectively applying electrical power to said heating means and to said tip including power control means having a high voltage terminal for connection to an ignition system for the engine, means electrically connecting said high voltage terminal to said tip, a low voltage terminal for connection to a power source, and switch means for selectively connecting said low voltage terminal to said heating means.

2. An ignition device, as set forth in claim 1, wherein said switch means includes means for simultaneously connecting said high voltage terminal to said shell when said low voltage terminal is connected to said heating means.

3. An ignition device, as set forth in claim 2, and wherein said power control means includes a solenoid, and means connecting said solenoid to actuate said switch means.

4. An ignition device, as set forth in claim 3, and wherein said power control means further includes a housing for said solenoid and said switch means, said housing including a sealed oil filled chamber, means mounting said switch means in said oil filled chamber, said oil in said chamber being an electrical insulator to prevent flashover at said switch means.

5. An ignition device, as set forth in claim 4, and including means for removably attaching said housing to said shell.

6. An ignition device, as set forth in claim 2, wherein said heating means comprises a heater coil having two ends, means mounting said coil within said tip chamber, means electrically connecting one end of said coil to said tip, and wherein said switch means electrically connects the low voltage terminal to the other end of said coil.

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