May 2, 1967 L. J. HAMILTON 3,317,774

SELF-CLEANSING SPARK PLUG WITH GAS FLOW DIRECTING MEANS

Filed March 2, 1965

FIG. 1

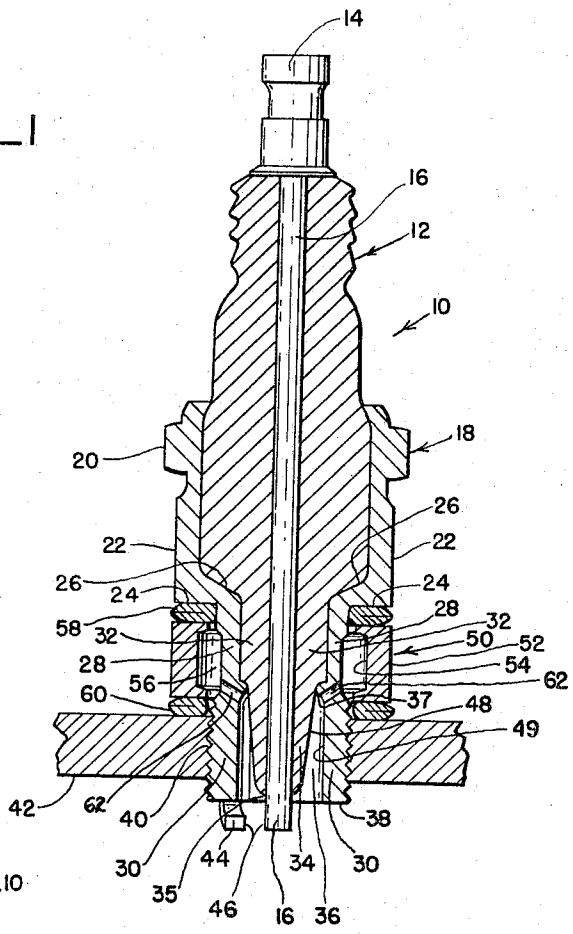


FIG. 3

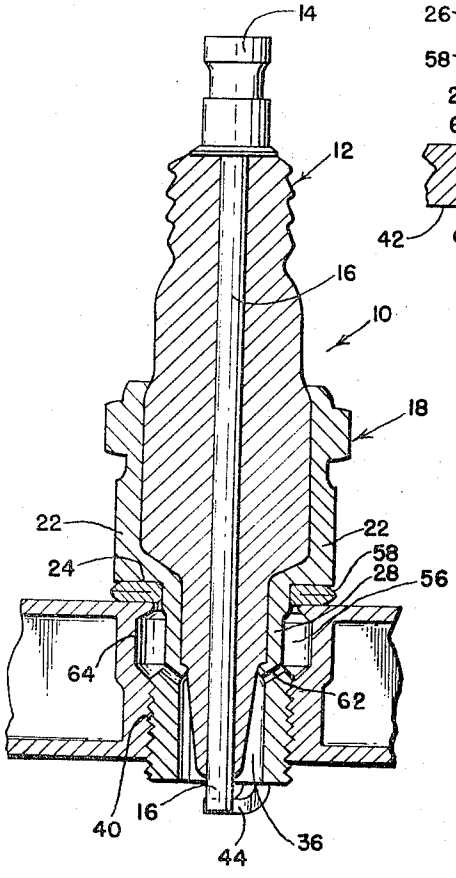
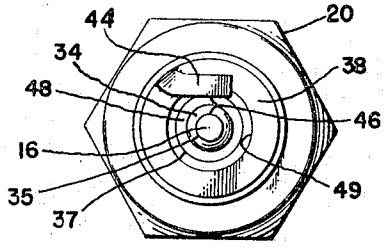


FIG. 2



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SELF-CLEANSING SPARK PLUG WITH GAS FLOW DIRECTING MEANS

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This invention relates to new and useful improvements in a sparkplug design, and more particularly does this invention relate to a sparkplug which has outstanding self-cleaning characteristics, and which also greatly reduces the problem of pre-ignition in internal combustion engines.

Most people are familiar with the problems that inhere in conventional sparkplugs. In automobile engines, it has been found that approximately twenty thousand miles of use is the maximum to which conventional plugs may be put. Most people also are aware that deposits build up on the plugs to cause them to short out and that engine knocking or pinging resulting from pre-ignition are major sources of concern. In other less widely-known areas, particularly in two-cycle engines such as chain saws and power lawn mowers, and in other two-cycle and four-cycle engines, the problem of keeping plugs clean is a particularly aggravating situation. Two-cycle engines cause sparkplug deposits to build up because of the oil used in the fuel. Four-cycle engines, particularly those in light service, permit oil to accumulate above the piston in the firing chamber and thus cause build-up and deposits on the plug. In order to accommodate the many types of spark ignition internal combustion engines, and the many uses to which they are put, it has been found necessary on the part of the sparkplug industry to design a wide range of plugs suited to particular applications and engines. The number of specific plug types presently on the market total many hundreds, and each type has been designed and built for a specific use, purpose, or application.

The theory of conventional plug structure embraces many considerations. High compression or hot running engines require cold plugs, while cold running engines, such as those with lower compression ratios and those used in light service, require a hot running plug. Generally, it can be stated that a hot running plug is one in which there is a long insulator portion on the firing end of the plug between the metal body surrounding the insulator and the electrodes. This long portion or nose permits heat to build up on the insulator before heat has begun to be dissipated or conducted to the metal body. The insulator nose or inner end of the sparkplug allows it to retain heat longer and therefore remain hot. A hot plug in hot engines such as a high compression or a racing-type engine, would operate at too high a temperature for the plug to withstand. The electrodes would either be burned away, or the points welded, or perhaps even the metal body portion break down under the high temperatures generated.

A short insulator nose conventionally is a so-called cold plug, since it dissipates heat more rapidly from the insulator nose to the body. This type of plug, since it is cold running, fouls out quickly if it is not used in a hot engine. Thus, it will be seen that the theory of plug design is based upon the heat range at which the plug may operate for the longest time without fouling. A balance must be drawn to a particular application on the one hand between letting the plug get too hot and burning it or developing pre-ignition, and on the other hand letting it operate at too cold a temperature which allows rapid build-up of deposits. Needless to say, many variations

are available in conventional plugs, between the hottest running and the coldest running types.

The theory underlying success of the instant invention is not fully understood. It was found after exhaustive study and testing of the plugs in many types of motors and applications that the sparkplug hereinafter described and claimed exhibited exceedingly encouraging results in life span compared to effective life of conventional plugs. Desirably, of course, in any plug the nose or inner end of the insulator should get hot enough to burn away deposits, but at the same time should not get so hot as to damage and thereby shorten the life of the plug. Ideally, if the insulator could be kept free of deposits without the plug's having to operate at too highly elevated temperatures, then said plug will have maximum life.

The instant invention involves essential improvements over conventional plug design. At the lower end of the plug the electrodes, instead of being spaced vertically from each other, that is the ground electrode spaced outwardly axially of the center electrode, they may be spaced radially from each other. In this sparkplug, the ground or side electrode may be gapped or spaced to the side of the center electrode so that relatively speaking, the gap or space is horizontal as opposed to vertical. A critical structural improvement is in the adapter ring above the threads and below the shoulder of the body. The adapter ring is responsible for creating an annular chamber around the narrower portion of the metal body, just below the body offset or shoulder. A critical structural improvement lies in the holes or ports at the upper end of the spark gap cavity where the insulator nose and the metal body join. The holes or ports lead from the top of the annular space or cavity formed on the inside of the threaded lower portion of the plug and surrounding the insulator nose into the chamber created by the adapter ring. When the piston moves to the top of the chamber during the compression stroke, air rushes upwardly past the points and the insulator nose and into the chamber to effect a scouring action. When the piston moves down, jet action from the chamber rushes out past the insulator nose and through the gap in the opposite direction. In this way the electrode points and the insulator nose are subjected to a drying and scouring action. These, then, are the essential and critical improvements which have been designed into this invention to overcome problems that inhere in conventional sparkplugs.

Accordingly, it is a prime feature of this invention to supply a sparkplug which has longer life than heretofore known sparkplugs.

Another feature of this invention is to provide a sparkplug which gives more complete combustion.

Still another feature of this invention is to furnish a sparkplug which substantially reduces pre-ignition.

Still another feature of this invention is to provide a sparkplug which is simple in design and competitive from a cost standpoint with conventional sparkplugs.

A further feature of this invention is to supply a sparkplug which has self-cleaning and self-drying characteristics.

An even further feature of this invention is to furnish a sparkplug in which the cleaning thereof is confined to the readily removable adapter ring, rather than to the area around the points and between the insulator nose and interior of the threaded portion of the plug body.

Yet a further feature of this invention is to provide a sparkplug which, because of its contribution to complete combustion, reduces dilution of engine oil with uncombusted gasoline.

Another feature of this invention is to provide a sparkplug, which because of its contributions to complete combustion, reduces smoke exhaustion.

Yet another feature of this invention is to supply a sparkplug which has particular application to two-cycle engines and to four-cycle engines in light service.

Still another feature of this invention is to furnish a sparkplug which, because of its contribution to complete combustion, increases gas mileage and enables the use of less expensive regular gasolines, thus conserving distributor breaker points, tailpipes and mufflers.

A yet further feature of this invention is to provide a sparkplug which is not prevented from firing because of water in the gas line or carburetor.

Still a further feature of this invention is to supply a sparkplug which is not prevented from firing as in the case of a flooded engine.

These, and other additional objects, advantages and features of the invention will be apparent from the following description and accompanying drawings, wherein:

FIGURE 1 is a cross-sectional view in elevation, of the preferred structure of applicant's novel sparkplug design;

FIGURE 2 is a bottom plan view of the sparkplug of FIGURE 1, showing further details of said sparkplug; and

FIGURE 3 is an elevational cross-sectional view of the sparkplug of this invention, showing an alternative embodiment for creation of the chamber in the heads of some specific makes of automobiles.

Referring now to the drawings, and particularly FIGURES 1 and 2, it will be seen that sparkplug **10** has porcelain or other insulator **12**, connector cap **14**, center electrode **16**, and metal body **18**. As is quite conventionally found in sparkplugs, body **18** is metal and rigidly attached to the lower portion of the sparkplug on insulator **12**. A wrench-engaging portion **20** at the upper end of the body permits a tool to seat and remove the sparkplug when desired. The metal body extends downwardly from the wrench-engaging portion in the form of a main body portion **22**, terminating with a radially inwardly offset shoulder surface **24**. It will be noted that the insulator also offsets in accordance with the offset in the body, as for instance at **26**. With the body and the insulator reducing in diameter at **24** and **26**, they in effect are narrowed down to form an intermediate body portion **28** which extends from the inner point of the offset or shoulder **24** to the threaded portion **30** of the body. It will be appreciated by those skilled in the art that relative dimensions of the parts of the sparkplug so far described will vary widely, depending upon the type of plug. It will be noted that insulator **12** also has an intermediate portion **32** which is encased by intermediate body portion **28**. At the lower end of the intermediate portions **28** and **32** of the body and the insulator it will be seen that the lowermost portion of the insulator or nose **34** separates from the threaded body portion **30** to provide an irregularly-shaped annular cavity **36** extending from the upper end of the nose **34** to the lowermost edge **38** of the threaded body portion **30**. The lowermost insulator portion or nose **34** terminates in reasonably close proximity to the plane of the lower end **38** of the metal body. A center electrode **16** protrudes beyond nose **34** and quite frequently outwardly beyond the lowermost end surface **38**. The outside surface of the lowermost body portion **30** has threads **40** for engaging motor block **42**.

It will be seen by reference to the drawings, that while center electrode **16** at the spark gap end remains substantially unchanged, ground electrode **44** can be seen to be spaced horizontally from the side of said center electrode **16**, so as to create horizontal spark gap **46**. Such horizontal spark gap **46** enables the gases moving past the spark gap area to help keep the spark gap clean and free of deposits which might short out the plug.

Another source of trouble in the conventional internal combustion engine sparkplug, is the spark gap cavity **36** and specifically surface **48** of insulator nose **34**. Surface **48**, especially in two-cycle engines and light service four-cycle engines, will gradually coat over until finally, the coating or deposit creates an electrical connection from the upper end of the cavity, as at **37**, along surface **48** to juncture **35**, thus connecting the center electrode with the grounded body. In this way such sparkplug is shorted or fouled out. Moving gas in this invention has been shown to have a salutary cleaning effect on the nose surface to retard deposit build-up.

A critical improvement resides in the adapter ring, generally designated by the number **50**, which is removably placed on and surrounds intermediate body portion **28** and intermediate insulator portion **32**. Adapter ring **50** has outer surface **52** and inner surface **54**, with the inner diameter surface thereof large enough to create an annular chamber **56** extending around the intermediate body portion. It will be noted that the upper edge surface of adapter ring **50** engages a sealing washer **58** and that likewise the lower edge of the adapter ring is engaged by a sealing washer **60**. Hence, the adapter ring **50** is disposed generally around the intermediate body portion above the threads and abutted at the top thereof, by the offset of the body, and at the lower edge surface of the ring by motor block **42**. In this way, annular chamber **56** is sealed from the atmosphere.

At the upper end of cavity **36** as defined by surfaces **48** and **49**, and very near juncture **37** where the metal and insulator join, at least one connecting port or hole **62** is formed through the metal body to communicate cavity **36** with chamber **56**. As a practical matter, the number of holes **62** may vary from as few as one to perhaps as many as 6 or more. It has been found, for instance, that one hole may be sufficient. Holes **62** have less volume than either spark gap cavity **36** below, or chamber **56** above. It has been found that the volume of chamber **56** can vary from as much as more than three times the volume of cavity **36** to slightly less than once the volume of cavity **36**. It must be realized that the volume variations of cavity **36** with respect to the volume of chamber **56** are numerous. The general volume range just stated appears to be preferred and is not considered limiting. Adapter ring **50** may have a straight inner wall or the inside surface may be dished slightly or even greater than shown in FIGURE 1. Plugs used in high compression engines will require a substantially smaller expansion chamber so as not to adversely affect the engine compression ratio. On the other hand, two-cycle and light service four-cycle engines which have the most serious fouling problems will require a substantial amount of expansion chamber volume. FIGURE 3 shows the plug of FIGURE 1 mounted in a block in which the threads for the plug are recessed and in which a cavity or recessed wall **64** is formed. The recess in the motor block by coacting with the shoulder or offset **24** and washer **58** defines an annular chamber as provided by ring **50** in the preferred embodiment.

It will be appreciated that modifications and changes will occur to those skilled in the art, and that the preferred embodiment shown is merely illustrative of the principles of this invention. Hence, it is not desired to limit the invention to the exact construction shown and described. Accordingly, all suitable modifications and equivalents may be resorted to which fall in the scope of the invention.

What is claimed is:

1. A sparkplug, comprising: (a) an elongate insulator having an upper end and a lower end and a center electrode extending generally axially therethrough, said insulator having a main section and an intermediate section of reduced diameter below said main section defining an inwardly offset portion and also having an end nose section below said intermediate section out of which nose extends said center electrode; (b) said sparkplug also including a metal body configured to encase the main and intermediate sections of said insulator and to include

a generally radially inwardly extending external and generally downwardly facing shoulder means, said metal body also being spaced from and enveloping said insulator nose section to define an annular cavity between said nose portion and said metal body; (c) a ground electrode connected to the lower end of said metal body and spaced from said center electrode to define a spark gap with respect to said center electrode; (d) an adapter ring removably received on said sparkplug sealingly abutting said shoulder and surrounding the reduced diameter intermediate portion of said metal body to define an annular chamber between said adapter ring and said metal body, said adapter ring being adapted to sealingly engage a motor block and thereby close said chamber to the atmosphere; and (e) at least one hole in said metal body communicating between the upper end of said annular cavity and said chamber.

2. A sparkplug comprising: (a) an elongate insulator having an upper end and a lower end and a center electrode extending generally axially therethrough, said insulator having a main section and an intermediate section of reduced diameter below said main section defining an inwardly offset portion and also having an end nose section below said intermediate section out of which nose extends said center electrode; (b) said sparkplug also including a metal body configured to encase the main and intermediate section of said insulator and to include a generally radially inwardly extending external shoulder means, said metal body also being spaced from and enveloping said insulator nose section to define an annular cavity between said nose portion and said metal body; (c) a ground electrode connected to the lower end of said metal body and spaced from said center electrode to define a spark gap with respect to said center electrode; (d) means adapted to be removably received in conjunction with said sparkplug sealingly abutting said shoulder and surrounding the reduced diameter intermediate portion of said metal body to define an annular chamber between said means and said metal body and thereby close said chamber to the atmosphere; and (e) at least one hole in said metal body communicating between the upper end of said annular cavity and said chamber, the opening in said at least one hole being less in volume than either said cavity or said chamber.

3. A sparkplug, comprising: (a) an elongate insulator having an upper end and a lower end and a center electrode extending generally axially therethrough, said insulator having a main section and an intermediate section of reduced diameter below said main section defining an inwardly offset portion and also having an end nose section below said intermediate section out of which nose extends said center electrode; (b) said sparkplug also including a metal body configured to encase the main and intermediate section of said insulator and to include a generally radially inwardly extending external shoulder means, said metal body also being spaced from and enveloping said insulator nose section to define an annular cavity between said nose portion and said metal body; (c) a ground electrode connected to the lower end of said metal body and spaced from said center electrode to define a spark gap with respect to said center electrode; (d) an adaptor ring removably received on said sparkplug sealingly abutting said shoulder and surrounding the reduced diameter intermediate portion of said metal body to define an annular chamber between said adapter ring and said metal body, said adapter ring being adapted to sealingly engage a motor block to thereby close said chamber to the atmosphere; and (e) at least one and as many as six holes in said metal body communicating between the upper end of said annular cavity and said chamber, the space in said one to six holes being less in volume than either said cavity or said chamber.

4. A sparkplug, comprising: (a) an elongate insulator having an upper end and a lower end and a center electrode extending generally axially therethrough, said insulator having a main section and an intermediate section of reduced diameter below said main section defining an inwardly offset portion and also having an end nose section below said intermediate section out of which nose extends said center electrode; (b) said sparkplug also including a metal body configured to encase the main and intermediate section of said insulator and to include a generally radially inwardly extending external shoulder means, said metal body also being spaced from and enveloping said insulator nose section to define an annular cavity between said nose portion and said metal body; (c) a ground electrode connected to the lower end of said metal body and spaced from said center electrode to define a spark gap with respect to said center electrode; (d) an adapter ring removably received on said sparkplug sealingly abutting said shoulder and surrounding the intermediate portion of said metal body to define an annular chamber between said adapter ring and said metal body which is closed to the atmosphere when said sparkplug is placed in a motor block; and (e) at least one hole in said metal body communicating between the upper end of said annular cavity and said chamber.

5. A sparkplug, comprising: (a) an elongate insulator having an upper end and a lower end and a center electrode extending generally axially therethrough, said insulator having a main section and an intermediate section of reduced diameter below said main section defining an inwardly offset portion and also having an end nose section below said intermediate section out of which nose extends said center eletcrode; (b) said sparkplug also including a metal body configured to encase the main and reduced diameter intermediate section of said insulator and to include a generally radially inwardly extending external shoulder means, said metal body also being spaced from and enveloping said insulator nose section to define an annular cavity between said nose portion and said metal body; (c) a ground electrode connected to the lower end of said metal body and spaced from said center electrode to define a spark gap with respect to said center electrode; (d) an adapter ring of larger inside diameter than said intermediate section of said metal body removably received on said sparkplug, said adapter ring having an upper edge surface sealingly abutting said shoulder and surrounding the intermediate portion of said metal body to define an annular chamber between said adapter ring and said metal body, said adapter ring also having a lower edge surface for sealingly engaging a motor block and thereby close said chamber to the atmosphere; and (e) at least one hole in said metal body communicating between the upper end of said annular cavity and said chamber.

6. A sparkplug, comprising: (a) an elongate insulator having an upper end and a lower end and a center electrode extending generally axially therethrough, said insulator having a main section and an intermediate section of reduced diameter below said main section defining an inwardly offset portion and also having an end nose section below said intermediate section out of which nose extends said center electrode; (b) said sparkplug also including a metal body configured to encase the main and reduced diameter intermediate section of said insulator and to include a generally radially inwardly extending external shoulder means, the lower section of said metal body also being spaced from and enveloping said insulator nose section to define an annular cavity between said nose portion and said metal body; (c) a ground electrode connected to the lower end of said metal body and spaced from said center electrode to define a spark gap with respect to said center electrode; (d) an adapter ring, the inside diameter of which is larger than said reduced diameter intermediate section of said metal body removably received on said sparkplug, said adapter ring having an upper edge surface sealingly abutting said shoulder and also surrounding the intermediate

portion of said metal body to define an annular sealed chamber between said adapter ring and said metal body, said adapter ring also having a lower edge surface for sealingly engaging a motor block and thereby closing said chamber to the atmosphere; and (e) at least one and as many as six holes in said metal body communicating between the upper end of said annular cavity and said chamber, the space in said one to six holes being less in volume than either said cavity or said chamber.

7. A sparkplug, comprising: (a) an elongate insulator having an upper end and a lower end, and a center electrode extending generally axially therethrough, said insulator having a main section and an intermediate section of reduced diameter below said main section defining an inwardly offset portion and also having an end nose section below said intermediate section out of which nose extends said center electrode; (b) said sparkplug also including a metal body configured to encase the main and reduced diameter intermediate section of said insulator and to include a generally radially inwardly extending external and generally downwardly facing shoulder means, said metal body also being spaced from and enveloping said insulator nose section to define an annular cavity between said nose portion and said metal body; (c) a ground electrode connected to the lower end of said metal body and spaced from said center electrode to define a spark gap with said center electrode; (d) an adapter ring removably received on said sparkplug, said adapter ring having an upper edge surface sealingly abutting said shoulder and surrounding the reduced diameter intermediate portion of said metal body to define an annular sealed chamber between said adapter ring and said metal body, said adapter ring also having a lower edge surface for sealingly engaging a motor block to thereby close said chamber to the atmosphere; and (e) at least one hole in said metal body communicating between the upper end of said annular cavity and said chamber, the volume of said chamber ranging from less than one to greater than three times the volume of said cavity.

8. A sparkplug, comprising: (a) an elongate insulator having an upper end and a lower end and a center electrode extending generally axially therethrough, said insulator having a main section and an intermediate section of reduced diameter below said main section defining an inwardly offset portion and also having an end nose section below said intermediate section out of which nose extends said center electrode; (b) said sparkplug also including a metal body configured to encase the main and reduced diameter intermediate section of said insulator and to include a generally radially inwardly extending external shoulder means, said metal body also being spaced from and enveloping said insulator nose section to define an annular cavity between said nose portion and said metal body; (c) a ground electrode connected to the lower end of said metal body and spaced from said center electrode to define a spark gap with said center electrode; (d) an adapter ring removably received on said sparkplug, said adapter ring having an upper edge surface sealingly abutting said shoulder and surrounding the intermediate portion of said metal body to define an annular sealed chamber between said adapter ring and said metal body, said adapter ring also having a lower edge surface for sealingly engaging a motor block to thereby close said chamber to the atmosphere; and (e) at least one hole in said metal body communicating between the upper end of said annular cavity and said chamber, the volume of said chamber ranging from less than one to greater than three times the volume of said cavity, and the volume of the opening in said at least one hole being less than the volume of either said cavity or said chamber,

9. A sparkplug, comprising: (a) an elongate insulator having an upper end and a lower end and a center electrode extending generally axially therethrough, said insulator having a main section and an intermediate section of reduced diameter below said main section defining an inwardly offset portion and also having an end nose section below said intermediate section out of which nose extends said center electrode; (b) said sparkplug also including a metal body configured to encase the main and intermediate section of said insulator and to include a generally radially inwardly extending external shoulder means, said metal body also being spaced from and enveloping said insulator nose section to define an annular cavity between said nose portion and said metal body; (c) a ground electrode connected to the lower end of said metal body and spaced from said center electrode to define a spark gap with said center electrode; (d) an adapter ring of larger inside diameter than said intermediate section of said metal body removably received on said sparkplug, said adapter ring having an upper edge surface abutting said shoulder and surrounding the intermediates portion of said metal body to define an annular chamber between said adapter ring and said metal body, said adapter ring also having a lower edge surface for engaging a motor block and thereby to close said chamber to the atmosphere; and (e) at least one hole in said metal body communicating between the upper end of said annular cavity and said chamber, the volume of said chamber ranging from less than one to greater than three times the volume of said cavity.

10. A sparkplug, comprising: (a) an elongate insulator having an upper end and a lower end and a center electrode extending generally axially therethrough, said insulator having a main section and an intermediate section of reduced diameter below said main section defining an inwardly offset portion and also having an end nose section below said intermediate section out of which nose extends said center electrode; (b) said sparkplug also including a metal body configured to encase the main and intermediate section of said insulator and to include a generally radially inwardly extending shoulder means, said metal body also being spaced from and enveloping said insulator nose section to define an annular cavity between said nose portion and said metal body; (c) a ground electrode connected to the lower end of said metal body and spaced from said center electrode to define a spark gap with said center electrode; (d) an adapter ring of larger inside diameter than said intermediate section of said metal body removably received on said sparkplug, said adapter ring having an upper edge surface abutting said shoulder and surrounding the intermediate portion of said metal body to define an annular chamber between said adapter ring and said metal body, said adapter ring also having a lower edge surface for engaging a motor block and thereby close said chamber to the atmosphere; and (e) at least one and as many as six holes in said metal body communicating between the upper end of said annular cavity and said chamber, the volume of said chamber ranging from less than one to greater than three times the volume of said cavity, and the volume of the total opening in said at least one to six holes being less than the volume of either said cavity or said chamber.

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