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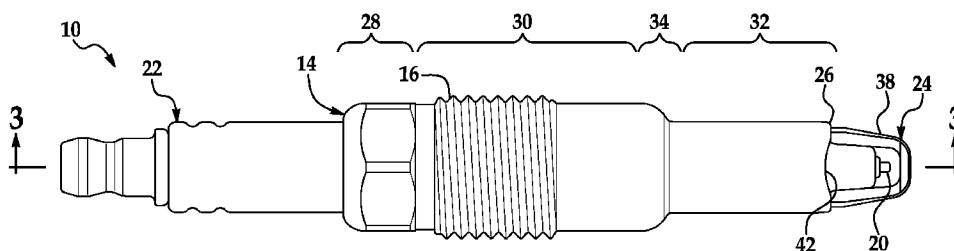


FIG. 2

(57) Abstract: A spark plug casing includes a single-piece shell having a nut portion, first and second tubular portions and a converging shell portion, which are configured to be removed from a cylinder head as an integral device. The first tubular portion extends from the nut portion and has a first cross-sectional size. The second tubular portion has a second cross-sectional size less than the first cross-sectional size. The converging shell portion is coupled between the first and second tubular portions. The casing further includes a ground strap having a third cross-sectional size less than the second cross-sectional size. The ground strap is received within an end portion of the second tubular portion opposite the converging shell portion, such that the ground strap and the cylinder head are in a spaced relationship with respect to each other for preventing carbon buildup from binding the ground strap to the cylinder head.



WO 2009/059275 A1

SPARK PLUG CASING AND  
SPARK PLUG HAVING THE SPARK PLUG CASING

CROSS REFERENCE TO RELEATED APPLICATIONS

This application claims the benefit of the following United States Provisional Patent application serial number 60/985,022 filed November 2, 2007, the contents of which are incorporated herein by reference thereto.

5 BACKGROUND OF THE INVENTION

Exemplary embodiments of the present invention relate to spark plugs for internal combustion engines, and more particularly to a spark plug configured to be easily indexed and removed from the engine cylinder head.

10 Spark plugs include a center electrode, an insulator disposed about the center electrode and a metal casing disposed about the insulator. The casing includes a jam nut shell that is hot-pressed to an end portion of a ground shield. The ground shield has a ground strap disposed in a spaced relationship with the center electrode for defining a spark gap therebetween.

15 The spark plug is indexed by marking the location of the spark gap on a portion of the plug that remains visible when the plug is installed on a cylinder head and then noting the direction in which the mark faces after the plug has been installed. The plug is then removed and re-installed on the cylinder head with additional washers, such that the orientation of the tightened plug is changed for directing the spark gap toward the valves. Such indexing is typically performed individually for each plug, as  
20 the orientation of the gap with respect to the threads of the shell can be random.

The spark plug is configured to dispose the ground strap adjacent to a surface of the cylinder head, such that carbon buildup on the ground strap can bind the ground strap to the cylinder head. Accordingly, removal of the spark plug can cause the ground strap to become detached from the ground shield and remain within the  
25 cylinder head.

Accordingly, it is desirable to provide a spark plug that is configured to be easily indexed and removed from a cylinder head.

#### BRIEF DESCRIPTION OF THE INVENTION

In accordance with a non-limiting exemplary embodiment of the invention, a spark plug casing is provided. The spark plug casing includes a first tubular portion extending from a nut portion. The first tubular portion has a first cross-sectional size and a threaded fastener configured to attach the spark plug casing to a cylinder head. The casing further includes a second tubular portion having a second cross-sectional size. The second cross-sectional size is less than the first cross-sectional size. The second tubular portion is configured to extend toward a combustion chamber past the cylinder head. The casing further includes a converging shell portion coupled between the first tubular portion and the second tubular portion. The nut portion, the first tubular portion, the second tubular portion and the converging shell portion comprise a single-piece shell such that the single-piece shell is configured to be removed from the cylinder head as an integral device. The casing further includes a ground strap having a third cross-sectional size. The third cross-sectional size is less than the second cross-sectional size. The ground strap is received within an end portion of the second tubular portion opposite the converging shell portion, such that the ground strap and the cylinder head are in a spaced relationship with respect to each other for preventing a buildup of carbon from binding the ground strap to the cylinder head.

In accordance with another non-limiting exemplary embodiment of the present invention, a spark plug is provided. The spark plug includes a center electrode, an insulator disposed about the center electrode and a spark plug casing disposed about the insulator. The spark plug casing includes a first tubular portion extending from a nut portion. The first tubular portion has a first cross-sectional size and a threaded fastener configured to attach the spark plug casing to a cylinder head. The casing further includes a second tubular portion having a second cross-sectional size. The second cross-sectional size is less than the first cross-sectional size. The second tubular portion is configured to extend toward a combustion chamber past the cylinder head.

The casing further includes a converging shell portion coupled between the first tubular portion and the second tubular portion. The nut portion, the first tubular portion, the second tubular portion and the converging shell portion comprise a single-piece shell such that the single-piece shell is configured to be removed from the cylinder head as an integral device. The casing further includes a ground strap having a third cross-sectional size. The third cross-sectional size is less than the second cross-sectional size. The ground strap is received within an end portion of the second tubular portion opposite the converging shell portion, such that the ground strap and the cylinder head are in a spaced relationship with respect to each other for preventing a buildup of carbon from binding the ground strap to the cylinder head.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective cutaway view of a cylinder head having a spark plug with a spark plug casing, according to a non-limiting exemplary embodiment of the invention;

Figure 2 is side plan view of the spark plug of Figure 1;

Figure 3 is a cross-sectional view of the spark plug of Figure 2, as taken along line 3-3;

Figure 4 is an axial view of the spark plug of Figure 2;

Figure 5 is a side plan view of the spark plug casing of Figure 1;

Figure 5A is an axial end view of the spark plug casing of Figure 5;

Figure 5B is a cross-sectional view of the spark plug casing of Figure 5A, as taken along line 5B-5B;

Figure 6 is a cross-sectional view of the ground strap of Figure 4, as taken along line 6-6;

Figure 7 is a cross-sectional view of the ground strap of Figure 4, as taken along line 7-7; and

Figures 8-11 are axial views of ground straps according to various alternative exemplary embodiments of the present invention.

## DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Exemplary embodiments of the present invention are directed to a spark plug having a spark plug casing configured to be easily indexed and removed from a cylinder head. In these embodiments, the casing has a single-piece shell and a ground strap that is attached to the shell. However, it is contemplated that the ground strap can instead be an integral portion of the single-piece shell.

Referring to Figure 1, there is shown a perspective cutaway view of a spark plug 10 installed in a cylinder head 12. The spark plug has a casing 14 with a high thread (“HT”) design, which includes a threaded fastener 16 configured to be disposed above a seat 18 of the cylinder head and force a portion of the casing against the seat, rather than be disposed beneath the seat and pull the casing onto the seat. Accordingly, combustion gases are more efficiently sealed in a combustion chamber of the engine and more space is available in the combustion chamber for optimizing engine design, e.g. installation of larger valves.

Referring to Figures 2 through 4, the spark plug includes a center electrode 20, an insulator 22 disposed about the center electrode and casing 14 disposed about the insulator.

Referring to Figures 5, 5A and 5B and in accordance with an exemplary embodiment of the present invention, the casing is a single-piece shell integrally formed with a nut portion 28 and a first tubular portion 30 extending from the nut portion. The first tubular portion has a first cross-sectional size and a threaded fastener 16 configured to attach the casing to the cylinder head.

The casing further includes an integrally formed second tubular portion 32 having a second cross-sectional size that is less than the first cross-sectional size. The second tubular portion is configured to extend toward a combustion chamber past the cylinder head.

The casing further includes an integrally formed converging shell portion 34 coupled between the first tubular portion and the second tubular portion. The converging shell portion is configured to be received within seat 18 of the cylinder head for sealing combustion gases within the combustion chamber of the engine. In the depicted embodiment, the converging shell portion is formed from two consecutive frustoconical portions of the casing. However, it is contemplated that the converging shell portion can instead be formed from more or less than two frustoconical portions or have a variety of other suitable shapes tapering in cross-sectional size from the first tubular portion to the second tubular portion.

The casing further includes a separately formed ground strap 24 (See for example Figures 6 and 7) that is secured to the single-piece shell and extends from an end portion 26 of the second tubular portion opposite the converging shell portion. The ground strap illustrated in Figures 6 and 7 has a ring portion 36 and an arcuate loop 38 extending across the ring portion (e.g., from one portion to another). The arcuate loop and the center electrode are in a spaced relationship with respect to each other for defining a spark gap therebetween. The ring portion has a third cross-sectional size that is less than the second cross-sectional size of the second tubular portion, such that the end portion of the second tubular portion is configured to receive the ring portion therein. As illustrated, the end portion of the second tubular portion includes a seat 40 and a rim portion 42. The ring portion is received within the seat and crimped between the seat and the rim portion. Accordingly, rim portion 42 is crimped over ring portion 36 to secure the same to the single-piece shell. It is further contemplated that the ground strap can instead be fixedly attached to the rim portion by spot welding, brazing, laser welding or other suitable attachment method.

Accordingly, the ground strap and the cylinder head are in a spaced relationship with respect to each other for preventing carbon from building up on the ground strap and binding the ground strap to the cylinder head. In this way, the spark plug is configured to be removed from the cylinder head without the ground strap or other portions of the casing remaining lodged in the cylinder head.

The casing, insulator and electrode are configured to be preassembled together and then placed in a fixture for attaching the ground strap to the casing in a predetermined position. Accordingly, the spark gap is located in a predetermined location with respect to other portions of the spark plug, and the step of determining the location of the spark gap is eliminated when indexing the spark plug. In other words, the ground strap will be added after the assembly of the other components of the plug and plug indexing will occur after the final assembly of the spark plug.

In this non-limiting embodiment and since the ground strap is separately formed, the ground strap is made of a high nickel alloy and has a first length. Further, the second tubular portion is made of a lower cost metal than high nickel alloy and has a second length, which is greater than the first length. Accordingly, the casing and the ground strap reduce the overall material costs of the spark plug.

Referring now to Figures 8-11 axial views of alternative ground straps are illustrated here the ground strap may be open in the center (Figures 8 and 9), a traditional "J" strap (Figure 10) or intersecting members (Figure 11) wherein an opening is provided therein. Again, the separately formed ground straps are formed from higher cost materials and separately secured to the integral casing of lower cost materials reducing the overall costs of the spark plug. As discussed, above each of the alternative ground straps would have a ring member 36 that is received in seat 40 and portion 42 is crimped over. Accordingly, all of the various embodiments of the alternative ground straps would depend away from a portion received and engaged within seat 40. Reference is also made to the following Patents 5,918,571; 5,697,334; and 6,104,130 the contents each of which are incorporated herein by reference thereto, wherein the aforementioned patents illustrate various ground strap configurations contemplated to be used with exemplary embodiments of the present invention.

While the invention has been described with reference to an exemplary embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing

from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the present application.

## CLAIMS

What is claimed is:

1. A spark plug casing, comprising:
  - 5 a nut portion;
  - a first tubular portion extending from the nut portion, the first tubular portion having a first cross-sectional size and a threaded fastener configured to attach the spark plug casing to a cylinder head;
  - a second tubular portion having a second cross-sectional size, the second cross-sectional size being less than the first cross-sectional size, the second tubular portion configured to extend toward a combustion chamber past the cylinder head;
  - 10 a converging shell portion coupled between the first tubular portion and the second tubular portion, wherein the nut portion, the first tubular portion, the second tubular portion and the converging shell portion comprise a single-piece shell such that the single-piece shell is configured to be removed from the cylinder head as an integral device; and
  - 15 a ground strap having a third cross-sectional size, the third cross-sectional size being less than the second cross-sectional size, the ground strap being received within an end portion of the second tubular portion opposite the converging shell portion, such that the ground strap and the cylinder head are in a spaced relationship with respect to each other for preventing a buildup of carbon from binding the ground strap to the cylinder head.
2. The spark plug casing as in claim 1, wherein the end portion of the  
20 second tubular portion has a seat configured to receive the ground strap.
- 25

3. The spark plug casing as in claim 2, wherein the ground strap has a ring portion and an arcuate loop extending across the ring portion, the ring portion being disposed within the seat, and the arcuate loop and the center electrode being in a spaced relationship with respect to each other for defining a spark gap therebetween.
- 5
4. The spark plug casing as in claim 3, wherein the end portion of the second tubular portion has a rim portion extending past the seat, the rim portion being attached to the ring portion.
- 10 5. The spark plug casing as in claim 4, wherein the rim portion is welded to the ring portion.
6. The spark plug casing as in claim 4, wherein the ring portion is crimped between the rim portion and the seat.
- 15
7. The spark plug casing as in claim 1, wherein the ground strap is made of a high nickel alloy.
8. The spark plug casing as in claim 7, wherein the ground strap has a first length, and the second tubular portion has a second length, and the second length being greater than the first length.
- 20
9. A spark plug, comprising:  
a center electrode;  
an insulator disposed about the center electrode; and  
a spark plug casing disposed about the insulator, the spark plug casing having a nut portion, a first tubular portion, a second tubular portion, a converging shell portion and a ground strap, the first tubular portion extending from the nut portion, the first tubular portion having a first cross-sectional size and a threaded fastener  
25 configured to attach the spark plug casing to a cylinder head, the second tubular portion having a second cross-sectional size, the second cross-sectional size being less than the first cross-sectional size, the second tubular portion configured to extend toward a  
30

combustion chamber past the cylinder head, the converging shell portion coupled between the first tubular portion and the second tubular portion, wherein the nut portion, the first tubular portion, the second tubular portion and the converging shell portion comprise a single-piece shell such that the single-piece shell is configured to be removed from the cylinder head as an integral device, and the ground strap having a third cross-sectional size, the third cross-sectional size being less than the second cross-sectional size, the ground strap being received within an end portion of the second tubular portion opposite the converging shell portion, such that the ground strap and the cylinder head are in a spaced relationship with respect to each other for preventing a buildup of carbon from binding the ground strap to the cylinder head.

10. The spark plug as in claim 9, wherein the end portion of the second tubular portion has a seat configured to receive the ground strap.
11. The spark plug as in claim 10, wherein the ground strap has a ring portion and an arcuate loop extending across the ring portion, the ring portion being disposed within the seat, and the arcuate loop and the center electrode being in a spaced relationship with respect to each other for defining a spark gap therebetween.
12. The spark plug casing as in claim 11, wherein the end portion of the second tubular portion has a rim portion extending past the seat, the rim portion being attached to the ring portion.
13. The spark plug casing as in claim 12, wherein the rim portion is welded to the ring portion.
14. The spark plug casing as in claim 12, wherein the ring portion is crimped between the rim portion and the seat.
15. The spark plug as in claim 9, wherein the ground strap is made of a high nickel alloy.

16. The spark plug as in claim 15, wherein the ground strap has a first length, and the second tubular portion has a second length, and the second length being greater than the first length.



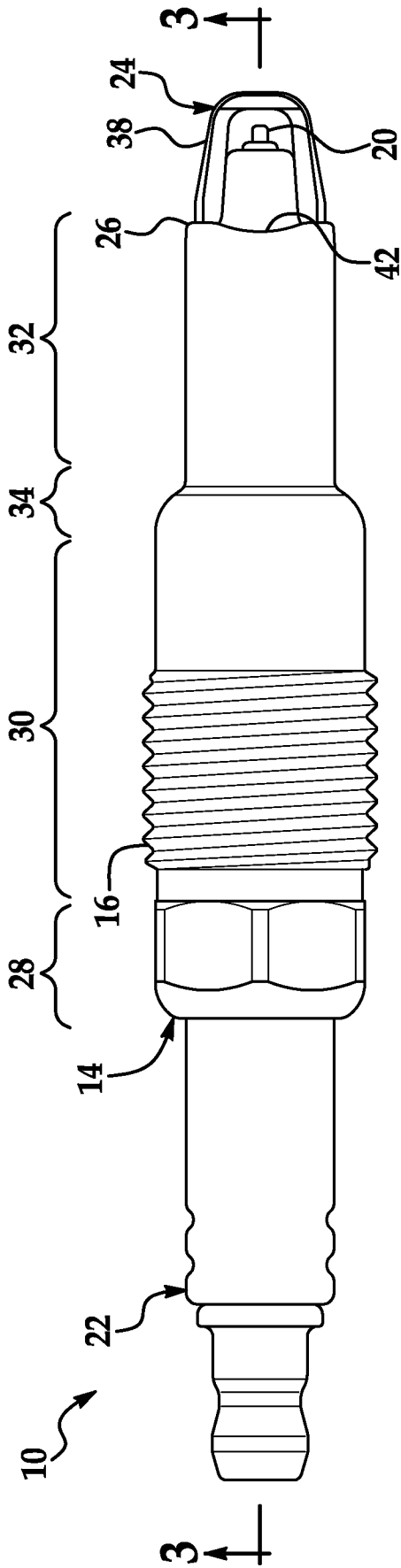


FIG. 2

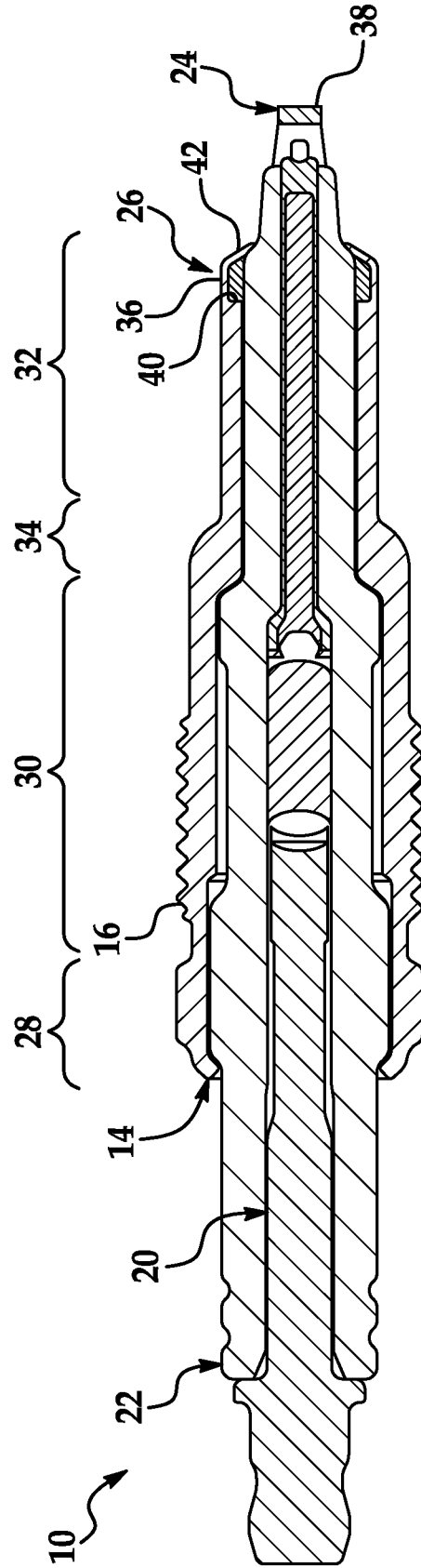


FIG. 3

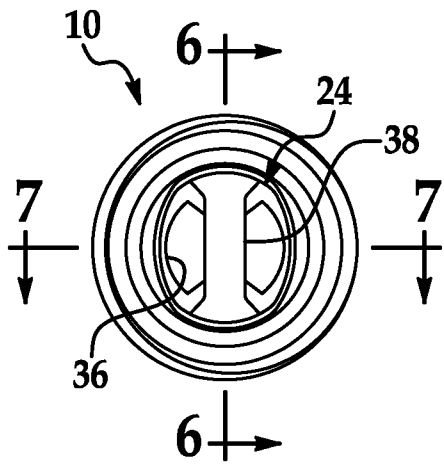


FIG. 4

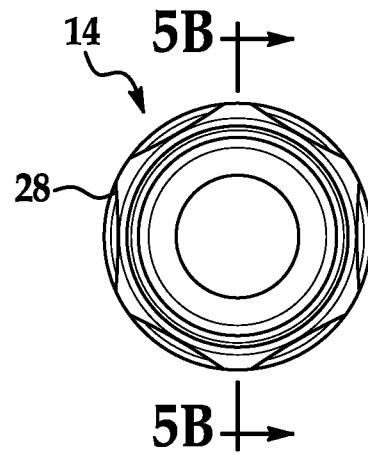


FIG. 5A

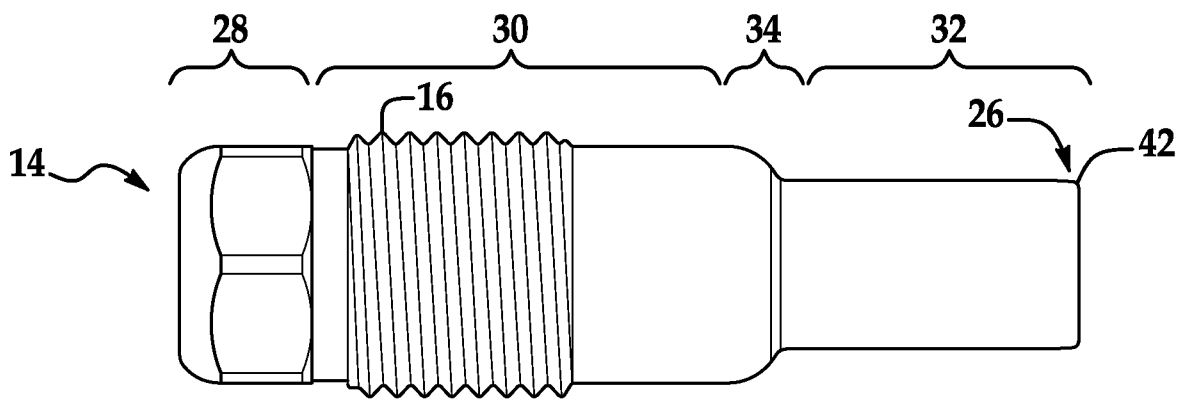


FIG. 5

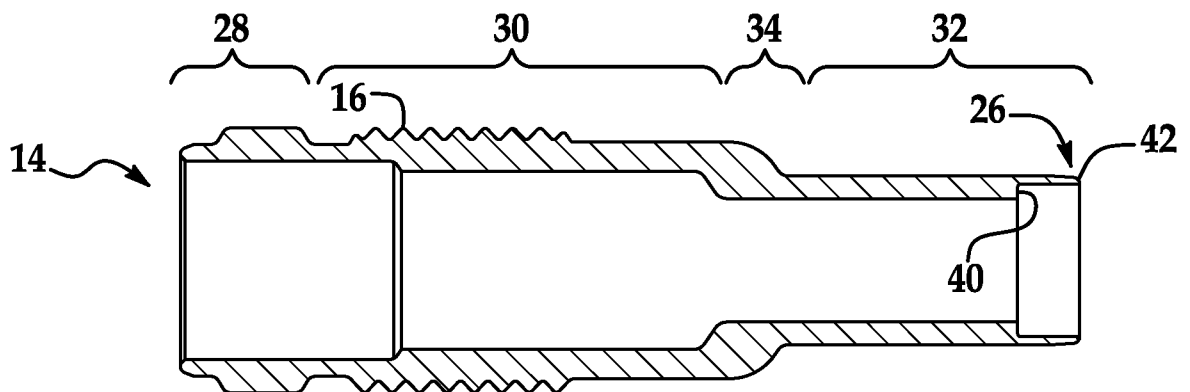


FIG. 5B

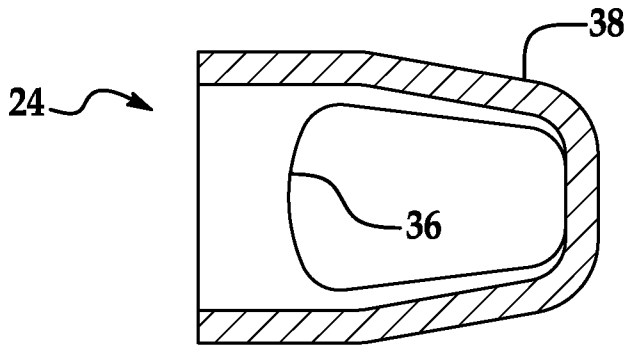


FIG. 6

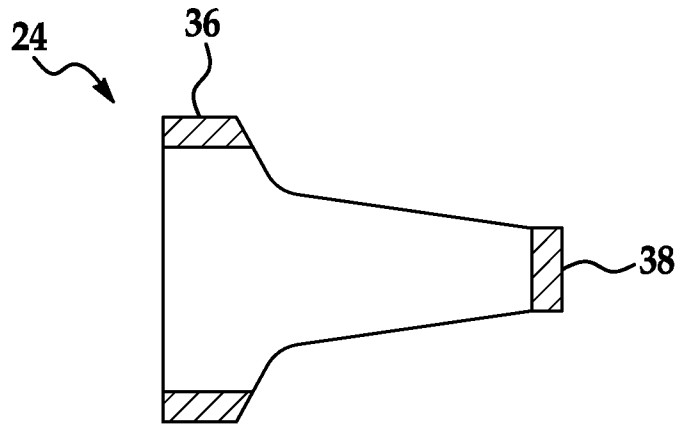


FIG. 7

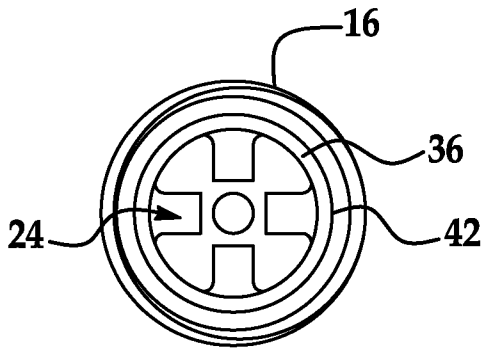


FIG. 8

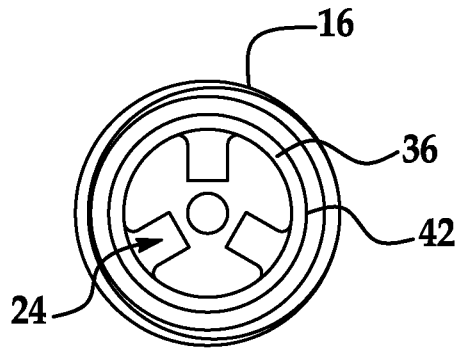


FIG. 9

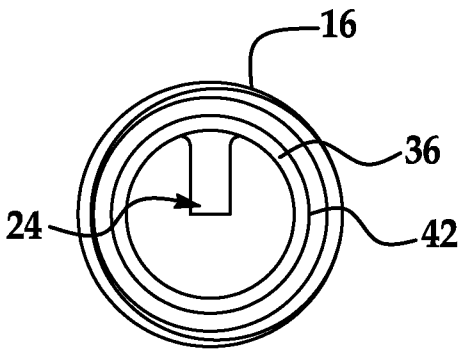


FIG. 10

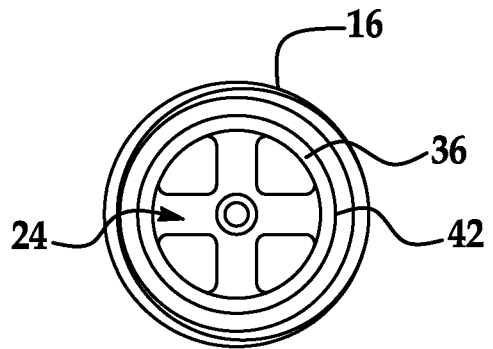


FIG. 11

**A. CLASSIFICATION OF SUBJECT MATTER***H01T 13/20(2006.01)i, H01T 13/02(2006.01)i*

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01T 13/20, H01T 13/46

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility Models since 1975

Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

D/B: eKIPASS(Searching System of KIPO)

spark, ignition, plug, casing, carbon, deposit, buildup

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2007/0252502 A1 (WANG), 1 November 2007, See Figs. 2-4, paragraphs [0016] to [0021]	1-16
A	US 6,316,868 B1 (ISHINO et al.), 13 November 2001, See Fig. 2, column 4 line 42 to column 5 line 3	1-16
A	JP 2001-093645 A (DENSO CORP.), 6 April 2001, See Figs. 1-3, paragraphs [0023] to [0029]	1-16
A	US 4,250,426 A (NAKAJIMA et al.) 10 February 1981, See Fig. 1, Abstract	1-16

 Further documents are listed in the continuation of Box C. See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

30 MARCH 2009 (30.03.2009)

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2008/082203**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007-0252502 A1	01.11.2007	NONE	
US 6316868 B1	13.11.2001	CA 2291351 A1 CA 2291351 C DE 69924344 D1 DE 69924344 T2 EP 1006631 A2 EP 1006631 B1 EP 1006631 A3 EP 1235319 A2 EP 1235319 A3 JP 2001-160475 A	04.06.2000 16.03.2004 28.04.2005 12.01.2006 07.06.2000 23.03.2005 31.01.2001 28.08.2002 06.04.2005 12.06.2001
JP 2001-093645 A	06.04.2001	DE 10046882 A1 GB 0023205 D0 GB 2354550 A US 6552476 B1	07.06.2001 01.11.2000 28.03.2001 22.04.2003
US 4250426 A	10.02.1981	NONE	