

FORM 1

SPRUSON & FERGUSON

APPLICATION ACCEPTED AND AMENDMENTS
ALLOWED 14-2-90

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

596321

APPLICATION FOR A STANDARD PATENT

Champion Spark Plug Europe S.A., of Avenue Leopold III, 2a, 7120 Binche, BELGIUM, hereby apply for the grant of a standard patent for an invention entitled:

Spark Plug for Internal Combustion Engine

which is described in the accompanying complete specification.

Details of basic application(s):-

Basic Applic. No: Country:

8721890

GB

Application Date:

17 September 1987

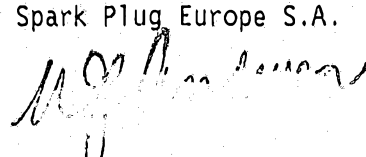
The address for service is:-

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DATED this FOURTEENTH day of SEPTEMBER 1988

Champion Spark Plug Europe S.A.

By:



Registered Patent Attorney

TO: THE COMMISSIONER OF PATENTS
OUR REF: 67432
S&F CODE: 52557

RECEIPT OF RECEIPT 584572 14/09/88

RECEIPT OF RECEIPT 5902342 14/09/88

COMMONWEALTH OF AUSTRALIA

THE PATENTS ACT 1952

DECLARATION IN SUPPORT OF A
CONVENTION APPLICATION FOR A PATENTIn support of the Convention Application made for a
patent for an invention entitled:AUSTRALIA
CONVENTION
STANDARD
& PETTY PATENT
DECLARATION

Title of Invention

Spark Plug for Internal Combustion Engine

Full name(s) and
address(es) of
Declarant(s)

I/We Jacques A. Bronchart and William H. Smith

of Champ de La Vallée, 7, 1328 Ohain (Lasne) and Avenue
Ferdauci 21, 1020 Brussels, both in Belgium, respectively

do solemnly and sincerely declare as follows:-

Full name(s) of
Applicant(s)

I am/We are the applicant(s) for the patent

(or, in the case of an application by a body corporate)

1. I am/We are authorised by Champion Spark Plug Europe S.A.

the applicant(s) for the patent to make this declaration on
its/their behalf.2. The basic application(s) as defined by Section 141 of the
Act was/were made

Basic Country(ies)

in Great Britain

Priority Date(s)

on 17 September, 1987

Basic Applicant(s)

by Champion Spark Plug Europe S.A.

Full name(s) and
address(es) of
inventor(s)3. I am/We are the actual inventor(s) of the invention referred
to in the basic application(s)

(or where a person other than the inventor is the applicant)

3. JACQUES A. BRONCHART

of Champ de La Vallée, 7, 1328 Ohain (Lasne), Belgium

(respectively)

is/are the actual inventor(s) of the invention and the facts upon
which the applicant(s) is/are entitled to make the application are
as follows:Set out how Applicant(s)
derive title from actual
inventor(s) e.g. The
Applicant(s) is/are the
assignee(s) of the
invention from the
inventor(s)CHAMPION SPARK PLUG EUROPE S.A. is entitled by Contract
of Employment between the inventor as employee and
CHAMPION SPARK PLUG EUROPE S.A. as employer, as a person
who would be entitled to have the patent assigned to it if
a patent were granted upon an application made by the
inventor.4. The basic application(s) referred to in paragraph 2 of this
Declaration was/were the first application(s) made in a Convention
country in respect of the invention(s) the subject of the application.

Declared at Belgium this 26 day of August 1988

JACQUES A. BRONCHART

WILLIAM H. SMITH

To: The Commissioner of Patents

Signature of Declarant(s)

(12) PATENT ABRIDGMENT (11) Document No. AU-B-22217/88
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 596321

(54) Title
SPARK PLUG FOR INTERNAL COMBUSTION ENGINE

International Patent Classification(s)
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SPRUSON & FERGUSON

(56) Prior Art Documents
GB 2164091
GB 2027797
US 4670684

(57) Claim

1. A spark plug comprising a shell, a central electrode, an insulator surrounding the central electrode, said central electrode having a top end portion and a bottom end portion, and further comprising a ground electrode of which one of its end portions is secured to said shell and of which the other of its end portions extends in front of the bottom end portion of the central electrode, wherein the ground electrode is longitudinally defined by an inner surface an outer surface and two lateral surfaces wherein at least in the area of the bottom end portion of the central electrode the inner surface of the ground electrode is larger than the outer surface of said electrode.

S & F Ref: 67432

FORM 10

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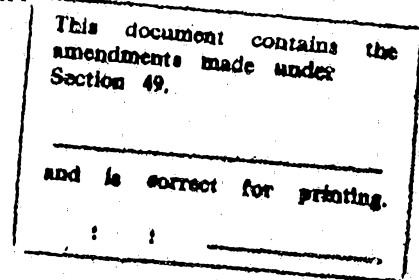
PATENTS ACT 1952

COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE:

Class Int Class



Complete Specification Lodged:

Accepted:

Published:

Priority:

Related Art:

596321

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Complete Specification for the invention entitled:

Spark Plug for Internal Combustion Engine

The following statement is a full description of this invention, including the best method of performing it known to me/us

ABSTRACT

The spark plug according to the invention comprises a shell (1), a central electrode (3) surrounded by an insulator (2) and a ground electrode (4) which, according to the invention, has a cross section (4a) such that the surface of the ground electrode (4) which is located nearest to the bottom end of the central electrode (3) is larger than the surface of the ground electrode (4) which is located farthest away from said bottom end of the central electrode (3). The ground electrode (4) may be provided with a copper core and its surface nearest to the bottom end of the central electrode (3) may be provided with a precious metal insert. The surface of the ground electrode which is farthest away from the bottom end of the central electrode (3) may be reduced to a line and the lateral surfaces of the ground electrode may be curved surfaces.

The present invention relates to a spark plug comprising a shell, a central electrode, an insulator surrounding the central electrode, said central electrode having a top end portion and a bottom end portion, and further comprising a ground electrode of which one of its end portions is secured to said shell and of which the other of its end portions extends in front of the bottom end portion of the central electrode, wherein the ground electrode is longitudinally defined by an inner surface, an outer surface and two lateral surfaces.

Spark plugs of the thus defined type are well known in prior art and are for example disclosed in U.S. patent 4,427,915, in U.S. patent 4,540,912 and in U.S. patent 4,568,855. The spark plugs of prior art, and in particular the spark plugs disclosed in the three mentioned U.S. patents, are generally provided with a ground electrode which has a rectangular cross section. Independently of the configuration of the central electrode the rectangular cross section of the ground electrode does not guarantee a maximal resistance to the erosion of the ground electrode. In other words, in giving a different configuration to the cross section of the ground electrode it is possible, as will be explained hereunder, to improve the resistance to erosion of the ground electrode, i.e. to prolong its life period.

The object of the invention is thus to provide a spark plug having a prolonged life period with respect to prior art spark plugs of the same type.

The spark plug according to the invention is substantially characterized by the fact that at least in the area of the bottom end portion of the central electrode the inner surface of the ground electrode is larger than the outer surface of said electrode.

Other features of the spark plug according to the invention are for example that :

- in the area of the bottom end portion of the central electrode the

- inner surface of the ground electrode is a flat surface,
- in the area of the bottom end portion of the central electrode the lateral surfaces of the ground electrode are flat surfaces,
 - in the area of the bottom end portion of the central electrode the lateral surfaces of the ground electrode are curved surfaces.

5 The life period of the thus described spark plug can still be improved by providing a ground electrode consisting of an outer layer and of an inner core made of different materials, the outer layer being for example made of a nickel alloy and the inner core being for example made of copper. Such a bi-metal ground electrode has a longer
10 life period because it has a better resistance to corrosion. Indeed the copper core evacuates more rapidly the heat existing in the free end portion of the ground electrode and the resistance to corrosion increases when the temperature of the ground electrode decreases.

- 15 Further features of the spark plug according to the invention will be better understood when reading the following portions of the description in conjunction with the appended drawings, wherein :
- Fig. 1, is a partial elevational view of a spark plug according to a first embodiment of the invention,
- 20 Fig. 2 is a view, along arrow II, of the spark plug of Fig. 1,
Fig. 3 is a bottom view of the spark plug of Fig. 1,
Fig. 4 is an axial, sectional view of the spark plug of Fig. 1,
Fig. 5 is an enlarged elevational view of a portion of the spark plug of Fig. 2,
- 25 Fig. 6 is an enlarged sectional view of a portion of a spark plug showing a first variant of the first embodiment of the invention,
Fig. 7 is an enlarged sectional view of a portion of a spark plug showing a second variant of the first embodiment of the invention,
- 30 Fig. 8 is, at a larger scale, a sectional view along line VIII - VIII of Fig. 6,
Fig. 9 is, at a larger scale, a sectional view along line IX - IX of Fig. 7,
- Fig. 10 is a partial elevational view of a spark plug according to a second embodiment of the invention, and
35 Fig. 11 is a bottom view of the spark plug of Fig. 10.

As can be seen in Figs 1 through 4 the spark plug according to

the first embodiment of the invention comprises : a shell 1 provided with a thread 1a, a central electrode 3 surrounded by an insulator 2 and a ground electrode 4 of which one of its end portions is secured to the shell 1 and of which the other of its end portions extends in front of the bottom end portion of the central electrode 3. In the area of the bottom end portion of the central electrode 3 the ground electrode 4 has a trapezoidal cross section 4a (Fig. 2).

The enlarged view of Fig. 5 shows that the trapezoidal cross section of the ground electrode 4 is defined by the inner surface 4', by the outer surface 4" and by the two lateral surfaces 4"', 4"" of said ground electrode.

As said above the ground electrode 4 is subject to erosion, i.e. said electrode is eroded by the sparks which bridge the gap between the free end portion of the ground electrode 4 and the central electrode 3. Said erosion affects only the inner surface 4' of the ground electrode 4, at least when the spark plug is relatively new, and it is evident that the importance of the erosion (as to the thickness of the eroded layer) depends on the size of the inner surface 4' which extends in front of the central electrode 3. The larger said surface 4' is, the less the erosion penetrates into the ground electrode. It is therefore advantageous to have an inner surface 4' as large as possible.

In the spark plug according to the first embodiment of the invention this knowledge has been put into practice by adopting a ground electrode 4 which has a trapezoidal cross section such as shown for example in Fig. 5. In fact the cross section of the ground electrode is not necessarily trapezoidal. Indeed it only matters that the inner surface 4' of the ground electrode 4 is larger than the outer surface 4" of said electrode. In other words the lateral walls 4"', 4"" of the ground electrode could for example be curved surfaces.

At the point where the ground electrode 4 is secured to the shell 1 (Fig. 4) said electrode should not project beyond the inner and/or the outer cylindrical surface of said shell. Moreover, because of the phenomenon known to the man of the art as "cold fouling" the diameter of the inner cylindrical surface 1b of the shell 1 should be maximized. This means, since the outer cylindrical surface of the shell 1 is determined by the thread in the engine, that the thickness of the shell 1 must be minimized.

In view of the above constraints ground electrodes having a rectangular cross section (see prior art) do not permit to have the largest possible inner surface without projecting beyond the inner ^{and/or} the outer cylindrical surface of the shell 1. The largest possible ~~and/or~~ inner surface of the ground electrode is obtained by a ground electrode wherein the inner surface is larger than the outer surface, i.e. by a ground electrode such as disclosed in the present specification.

"Cold fouling" is a phenomenon wherein, when the engine and the spark plugs are cold, the sparks have a tendency not only to bridge the gap between the central electrode 3 and the ground electrode 4, but also to bridge the gap between the central electrode 3 and the shell 1. This phenomenon should be avoided because of its negative consequences on the normal functioning of the spark plug.

Fig. 5 shows how the ground electrode according to the invention is eroded with time. The ground electrode is first eroded directly underneath the central electrode 3 and after a certain period of time the inner surface 4' of the ground electrode has taken the form shown by the interrupted line 4'a. In conventional spark plugs said line 4'a substantially corresponds to the whole inner surface of the ground electrode, i.e. in conventional spark plugs the lateral surfaces of said electrode would be eroded after said first period of time.

However, in the spark plug according to the invention the lateral surfaces 4"', 4''' of the ground electrode 4 are only eroded after a second period of time, i.e. when the inner surface 4' has taken the form shown by the interrupted line 4'b. Moreover, since the total volume of material taken away from the ground electrode of similar spark plugs working under similar conditions can be considered as being substantially the same, the thickness (distance between the inner surface 4' and the outer surface 4'') of the ground electrode according to the invention will diminish less quickly than the thickness of the ground electrode of a conventional spark plug. In other words, the spark plug according to the invention has a longer life period than similar conventional spark plugs.

Figs 6 and 8 show a first variant of the ground electrode according to the first embodiment of the invention. In this variant the ground electrode 5 is made of two different materials, the outer layer 5c being for example made of a nickel alloy and the inner



core 5b being for example made of copper.

As already explained above the object of the copper-core 5b is to evacuate more rapidly the heat existing in the free end portion of the ground electrode 5 and thus to increase the life period of said electrode by a better resistance to corrosion.

The ground electrode 6 of Figs 7 and 9 embodies a second variant of the ground electrode according to the first embodiment of the invention. In this variant the ground electrode is not only made of an outer layer 6c (e.g. nickel alloy) and of an inner core 6b (e.g. copper), but in the area of the bottom end portion of the central electrode the inner surface 6' is further provided with an insert 6d made of a precious metal.

The object of the precious metal insert 6d is to still prolong the life period of the ground electrode. Indeed most precious metals have a better resistance to erosion than the nickel alloys generally used for manufacturing the ground electrodes of spark plugs.

As can be seen in Figs. 8 and 9 the ground electrodes 5, 6 of the two variants of the first embodiment of the invention both have a trapezoidal cross section 5a, 6a respectively defined by the surfaces 5', 5'', 5''', 5'''' and 6', 6'', 6''', 6''''.

Figs 10 and 11 show the second embodiment of the invention, said embodiment comprising : a shell 1 provided with a thread 1a, a central electrode 3 surrounded by an insulator 2 and a ground electrode 7. In the area of the bottom end portion of the central electrode 3 the ground electrode 7 has a triangular cross section 7a.

The triangular cross section 7a (inner surface 7' and lateral surfaces 7'', 7''') of this ground electrode is in fact only a limit case of the trapezoidal cross section 4a, 5a, 6a of the first embodiment of the invention wherein the outer surface 4'', 5'', 6'' has been reduced to a line (7'') and therefore the above explanations on erosion and on corrosion (Figs 5 through 9) also apply to this second embodiment of the invention. In particular the triangular shaped ground electrode 7 can be provided with a copper core and/or with a precious metal insert. It is further to be noted that the lateral surfaces 7'', 7''' can be either flat or curved surfaces.



The claims defining the invention are as follows:

1. A spark plug comprising a shell, a central electrode, an
5 insulator surrounding the central electrode, said central electrode having
a top end portion and a bottom end portion, and further comprising a ground
electrode of which one of its end portions is secured to said shell and of
which the other of its end portions extends in front of the bottom end
10 portion of the central electrode, wherein the ground electrode is
longitudinally defined by an inner surface an outer surface and two lateral
surfaces wherein at least in the area of the bottom end portion of the
central electrode the inner surface of the ground electrode is larger than
the outer surface of said electrode.
2. A spark plug according to claim 1, wherein in the area of the
15 bottom end portion of the central electrode the inner surface of the ground
electrode is a flat surface.
3. A spark plug according to either claim 1 or 2, wherein in the
area of the bottom end portion of the central electrode the lateral
surfaces of the ground electrode are flat surfaces.
- 20 4. A spark plug according to claim 3, wherein in the area of the
bottom end portion of the central electrode the outer surface of the ground
electrode is reduced to a line.
5. A spark plug according to any one of claims 1, 2 or 4, wherein
in the area of the bottom end portion of the central electrode the lateral
25 surfaces of the ground electrode are curved surfaces.
6. A spark plug according to any one of claims 1 to 5, wherein the
ground electrode consists of an outer layer and of an inner core made of
different materials.
- 30 7. A spark plug according to any one of claims 1 to 6, wherein in
the area of the bottom end portion of the central electrode the inner
surface of the ground electrode is provided with an insert made of a
precious metal.

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8. A spark plug substantially as hereinbefore described with
reference to Figures 1 to 5, 6 and 8, 7 and 9, or 10 and 11 of the drawings.

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DATED this TWENTY NINTH day of JANUARY 1990
Champion Spark Plug Europe SA

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Patent Attorneys for the Applicant
SPRUSON & FERGUSON

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FIG. 1

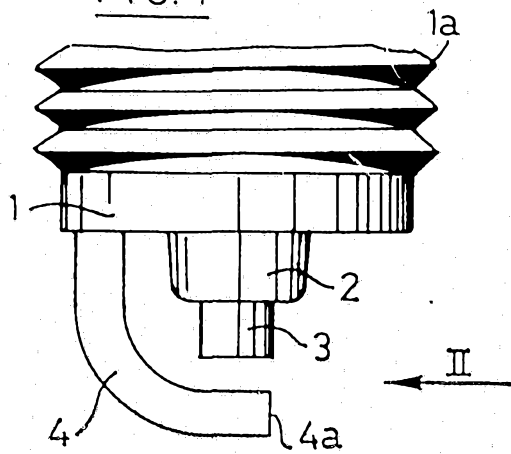


FIG. 2

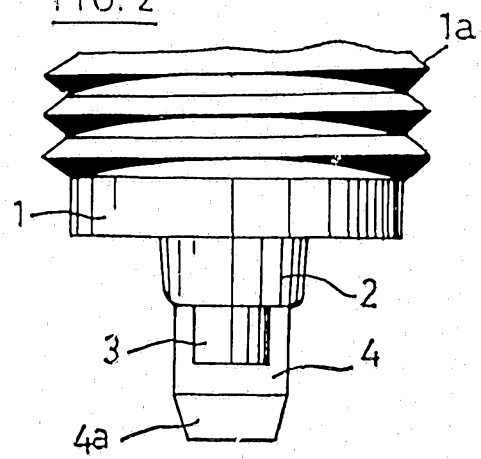


FIG. 3

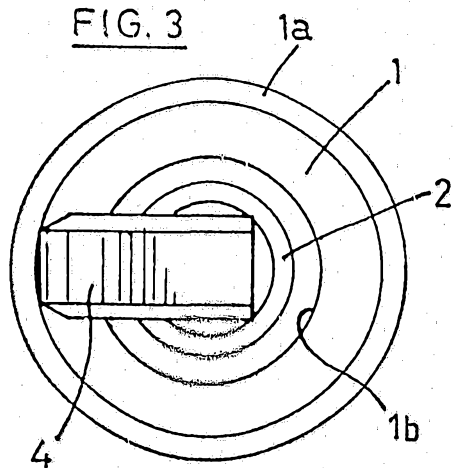


FIG. 4

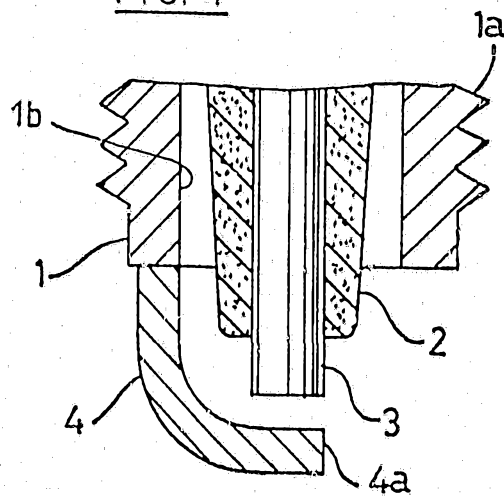
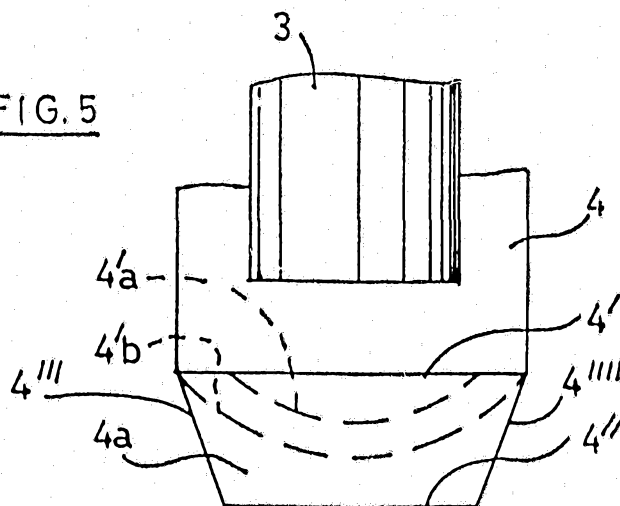


FIG. 5



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