Dec. 9, 1952 C. CIPRIANI 2,620,784

SPARK PLUG CONSTRUCTION

Filed July 15, 1950

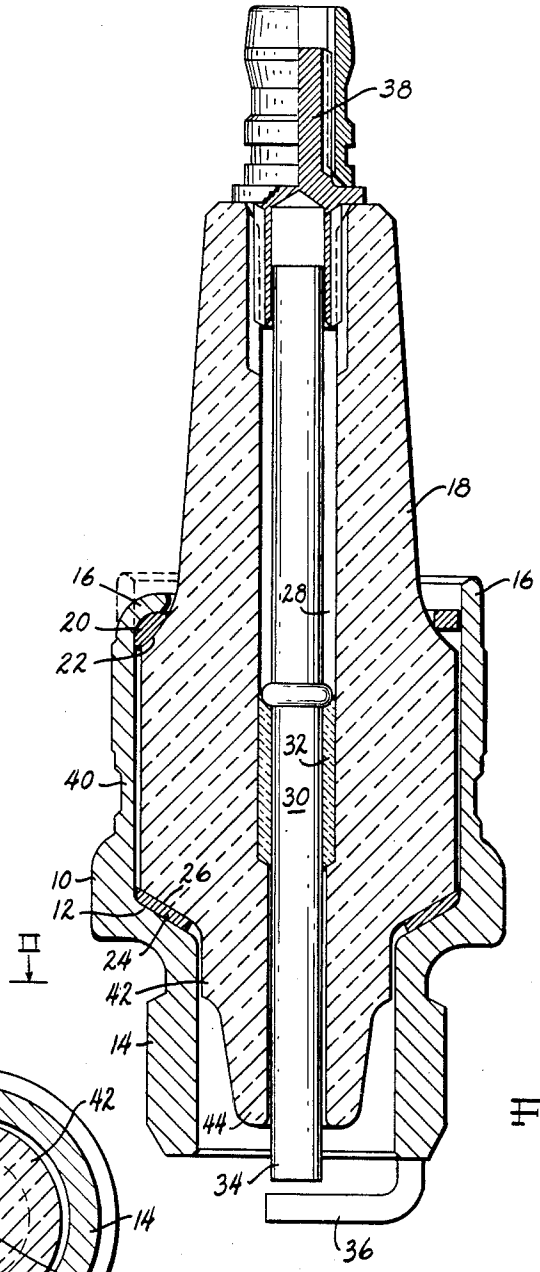


FIG. I

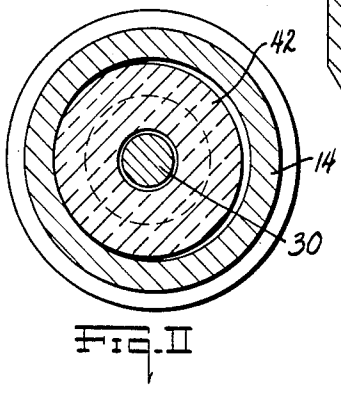


FIG. II

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Patented Dec. 9, 1952

2,620,784

UNITED STATES PATENT OFFICE

2,620,784

SPARK PLUG CONSTRUCTION

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Application July 15, 1950, Serial No. 174,097

5 Claims. (Cl. 123—169)

1

This invention relates to spark plugs, more particularly to the seal between the ceramic insulator and the metallic shell thereof, wherein a "hot press" seal is utilized.

The so-called "hot press seal" for sealing spark plug shells to their ceramic insulators has been satisfactory in the past for spark plugs of relatively low heat ranges, but with the advent of higher output engines and relatively colder spark plugs necessary to be used in connection therewith, this seal is no longer entirely satisfactory as being unreliable. Generally speaking, the colder plugs are manufactured by placing the lower sealing gasket nearer the firing tip of the insulator so, for a given insulator, greater heat conductivity is obtained to make the spark plug colder to allow its use in these high output engines. The gasket seat on some spark plugs must, therefore, be placed in the lower threaded portion of the shell, which is undesirable due to the stresses in this section when the spark plug is positioned in the engine cylinder, so that the efficiency of the seal is strongly influenced. It is, therefore, essential that this gasket seat is placed above the threaded section and, when this is done, the insulator tip must be placed in close proximity with the seal adjacent its firing tip to get the necessary heat conductivity to give a plug cold enough to be used with the aforementioned engines. In using this solution of the problem, an undesirable result is obtained, in that the clearance between the insulator firing tip portion and the circumambient shell becomes very small and subject to lead fouling which soon adversely influences the efficiency of the spark plug.

The present invention contemplates the provision of a hot press seal for a spark plug wherein these difficulties are obviated, and a spark plug is contemplated wherein the lower gasket seat for the insulator is above the threaded section and wherein the clearances are of such proportion to reduce the possibility of lead fouling in the firing tip section. The spark plug contemplated by this invention is a so-called "cold" type with space factors which allow ready cleansing of contamination after considerable operation by the use of a sand blast type of spark plug cleaner.

It is, therefore, a principal object of this invention to provide a spark plug having a hot-

2

press seal with a "cold" heat rating, which has its lower gasket seat above its threaded shell section and which has relatively large clearances adjacent its firing tip to obviate lead fouling and to allow ready cleaning of the spark plug.

Other objects and advantages of this invention relating to the arrangement, operation and function of the related elements of the structure, to various details of construction, to combinations of parts and to economies of manufacture, will be apparent to those skilled in the art upon consideration of the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Fig. 1 of the drawings is a sectional elevation of a spark plug incorporating the invention, and Fig. 2 is a plan view, partly in section, taken along line 2—2 of Fig. 1.

In carrying out this invention into a practical application thereof, a shell of suitable metal 10 is provided which has an internal shoulder 12 positioned above an external threaded portion 14 which is used to fit the spark plug into a suitable opening in a cylinder of an internal combustion engine. The upper end of the shell is provided with an upstanding lip 16 which is utilized to hold an insulator 18 in position in the shell, as is well known in the prior art, the lip being inturned by cold pressing over a gasket 20 seated on the upper shoulder 22 of the insulator. A second gasket 24 is provided to seat on the internal shoulder 12 of the shell to cooperate with the lower shoulder 26 of the insulator, as is clearly shown in Fig. 1.

The insulator 18 is provided with a central bore 28 in which is fitted a central electrode 30 of suitable material, being sealed therein by a compacted fibrous sealing body 32. The lower end 34 of the central electrode cooperates with a grounded electrode 36 welded to the lower end of the threaded section 14 of the shell as is well known in the art. The upper end of the center electrode is provided with a terminal portion 38 which is suitably threaded into the upper end of the insulator 18.

A seal between the insulator 18 and the shell 10 is provided by the gaskets 20 and 24, which are placed into longitudinal compression by col-

lapsing an attenuated portion 40 of the shell when the same is in a thermoplastic state by the use of heat and pressure substantially as set forth in Middleton Patent No. 2,111,916. Due to the relatively high temperatures used during the collapsing period, the compression will always be maintained on the gaskets when the spark plug is used under normal conditions, so that the seal will be maintained between the parts. The cooling of the shell after its thermo-plastic collapse causes a contraction to occur which maintains this compression which is not relaxed during normal use of the spark plug because the temperatures are too low and do not cause sufficient expansion.

Seals of this type which utilize longitudinal compression are not suitable for use in spark plugs where the lower gasket seat 12 is positioned in the threaded section 14, because the threaded section is subjected to severe stresses in torsion when the spark plug is positioned in the engine block which, in many cases, destroys the seating of the lower gasket in a way to break the seal. On the other hand, if the internal shoulder is put above the threaded section 14 and it is necessary to design a so-called "cold" plug having an I. M. E. P. of, say 200, the insulator tip must have its tip enlarged to give a

$$\frac{\text{space}}{\text{volume}}$$

ratio of at least

$$\frac{40}{1}$$

which will give a very small clearance between the insulator and the internal bore of the threaded section 14. This is undesirable when the spark plug is to be used with leaded fuels inasmuch as lead deposits readily form in the narrow annular space between shell and insulator to thereby reduce the efficiency of the insulator. The cleansing of the spark plug by the use of sandblast jets in this type of plug is also not satisfactory.

In order to overcome these limitations on the use of seals of this type, namely, one utilizing longitudinal compression on the gaskets, the insulator of a spark plug incorporating the invention is provided with depending cylindrical portion 42 positioned below the lower shoulder 26 on the insulator. The cylindrical portion 42 of the insulator is given a dimension to closely nestle within the bore of the shell below the internal seat 12 with allowance for reasonable manufacturing tolerances. Its longitudinal dimension may vary somewhat but it is preferable to balance the design factor in such a way that the surface of the insulator below the gasket 24, as measured in square inches, is less than the ratio of

$$\frac{25}{1}$$

to the volume (measured in cubic inches) between the shell and the insulator. In other words, the

$$\frac{\text{surface}}{\text{volume}}$$

ratio below the lower gasket is less than

$$\frac{25}{1}$$

where the surface is the exposed surface of the insulator in square inches and the volume is the space between the insulator and the internal bore of the shell measured in cubic inches. The firing tip 44 of the insulator is given a tapering form depending upon the ratio given above for its size and volume. In some cases, it is desirable to give the firing tip and the cylindrical sections of the insulator below the lower gasket approximately equal dimensions.

Heat transfer from the insulator to the shell is facilitated by the close proximity of the cylindrical portion and the shell. In some cases, due to eccentricities during manufacture, the insulator and shell may touch on one side as is clearly shown in Fig. 2 to thereby transfer heat by direct conduction. The tapering of the firing tip portion of the insulator can be varied but consideration should be given to the clearances between insulator and shell to give as great a free space as the design allows to facilitate cleansing by a sand-blast jet. The larger the clearances in the tip portion, the less likely lead deposits are to appear due to the scrubbing action of the coursing gases in the combustion chamber.

It is to be understood that the above detailed description of the present invention is intended to disclose an embodiment thereof to those skilled in the art, but that the invention is not to be construed as limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of being practiced and carried out in various ways without departing from the spirit of the invention. The language used in the specification relating to the operation and function of the elements of the invention is employed for purposes of description and not of limitation, and it is not intended to limit the scope of the following claims beyond the requirements of the prior art.

What is claimed is:

1. In a one-piece spark plug having a threaded metallic shell and a shouldered insulator seated therein between a lower internal gasket seat and an inturned upper lip, a section of the shell between the lip and the seat collapsed while in hot plastic state to maintain a continual pressure on the insulator to urge the insulator against the gasket seat to provide a seal, said gasket seat being located at the upper terminus of the lower cylindrical shell portion above the threaded section of the shell, a depending cylindrical portion terminating in a secondary shoulder on the insulator below its enlarged shoulder to nestle closely into the lower cylindrical shell portion within manufacturing tolerances in the threaded portion of the shell, and a tip portion on the insulator below the secondary shoulder extending freely inwardly of the cylindrical shell portion to form the firing tip of the spark plug.

2. The spark plug defined in claim 1 further characterized by a tip portion having a

$$\frac{\text{surface}}{\text{volume}}$$

ratio of less than

$$\frac{25}{1}$$

3. The spark plug defined in claim 1 further characterized by a tip portion of the insulator approximately the same length as the depending cylindrical portion thereof.

4. In a one-piece spark plug sealed vertically by compression against a gasket seat, including a shouldered insulator housing a center electrode and a shell having an internal shoulder forming the gasket seat and a lower tubular member with a threaded outer portion below the internal shoulder, a pair of free insulator portions formed on

the insulator below the gasket seat of approximately equal length, the portion nearest the gasket seat providing a cylinder nestling close to the tubular shell in the threaded portion to provide heat transfer means therebetween, the second portion being attenuated freely inwardly to form a tip portion having a

$$\frac{\text{space}}{\text{volume}}$$

ratio less than

$$\frac{25}{1}$$

to provide ample clearance for the firing tip to obviate fouling and to facilitate cleaning.

5. The spark plug defined in claim 4 further characterized by an upper inturned lip on the shell and a thermo plastically collapsed portion of the shell to compress the insulator against the

gasket seat to provide the seal between the insulator and the shell.

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