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SPARK PLUG

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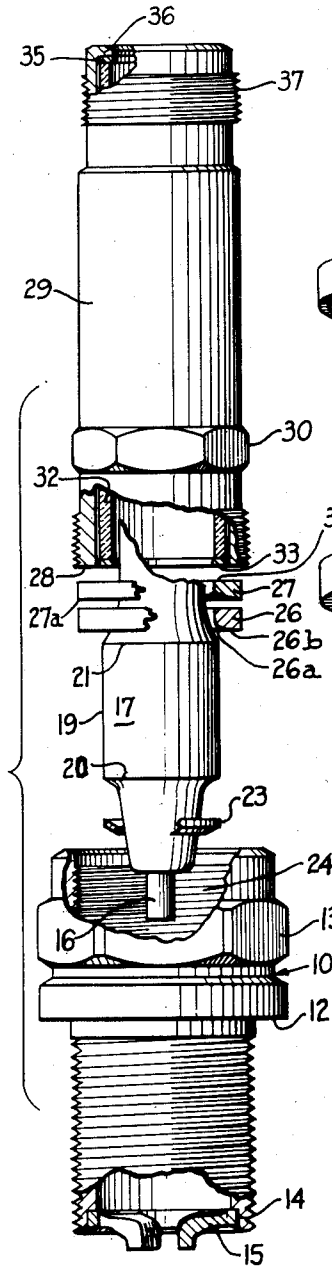



Fig. 2

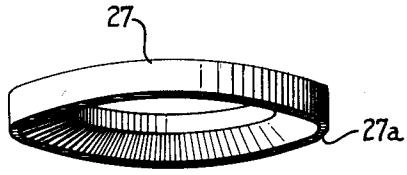



Fig. 4

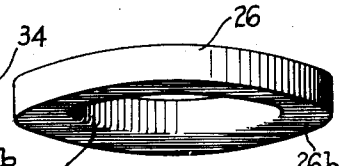



Fig. 5

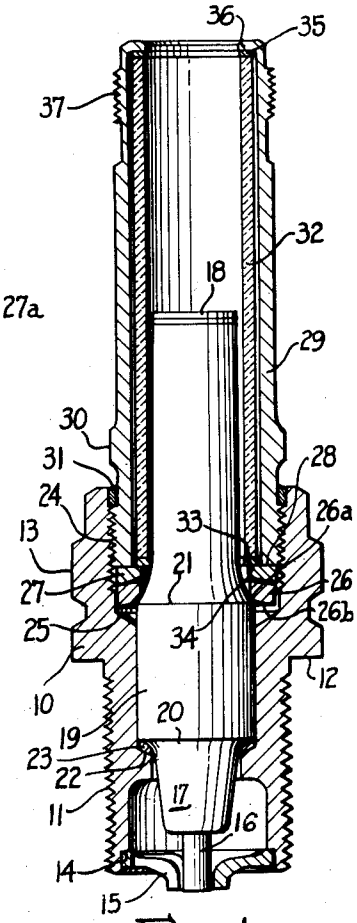



Fig. 1

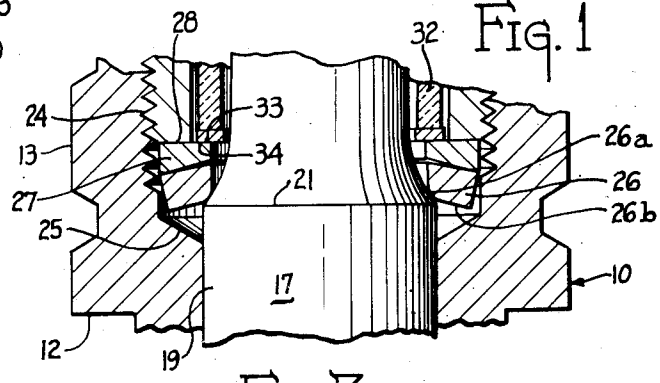



Fig. 3

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## SPARK PLUG

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8 Claims. (Cl. 123—169)

This invention relates to spark plugs, more particularly to the methods of holding and sealing a ceramic insulator in the metallic shell of a spark plug.

One of the major problems involved in manufacturing a spark plug, particularly a spark plug for use in airplanes wherein shielding devices are incorporated in the body of the spark plug, has been to maintain a seal between a ceramic insulator and the metallic shell in which the insulator is mounted. The metallic shell, and the ceramic insulator mounted therein, have widely varying coefficient of expansion which must be compensated in order that leakage will not develop while the plug is in use in the motor of an airplane. The temperatures to which the spark plug is subjected while in use vary widely under the operative conditions of the airplane motor and, in order that the plug may be maintained tight, the different expansion rates of the materials used in the plug must be fully compensated for. One of the means used to compensate for the very variable coefficient of expansion of the different materials has been a spring member positioned between the insulator and the shell which offers a resilient means to compensate for these different expansion rates while the plug is in use to maintain the required seal. In the prior art different types of spring members have been suggested for this purpose.

This invention contemplates the provision of a spring member which is highly adaptable for this purpose, which is capable of being easily manufactured, and which will result in a combination which is highly efficacious in maintaining a seal between the ceramic insulator and metallic shell of a spark plug, particularly of an aviation spark plug.

It is, therefore, a principal object of this invention to provide a resilient means positioned between the metallic shell and the insulator of a spark plug which is capable of compensating for variations of expansion of the different materials used in the fabrication of the spark plug so as to maintain a seal between the parts under all operating temperatures to which the spark plug will be subjected during use in an internal combustion engine.

It is a further object of this invention to provide a resilient means for use between the insulator and the shell of a spark plug to maintain a seal therebetween which is sufficiently flexible to prevent localization of bearing stresses upon the insulator and allow equalization thereof to obviate breakage of the insulator.

It is a further object of this invention to provide a resilient means positioned between the shell and the insulator of a spark plug which does not present insurmountable manufacturing difficulties and which will be efficacious in compensating for variations of expansion of the various materials used in the spark plug throughout the temperature range of the engine in which the spark plug is used.

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 drawing forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Fig. 1 is a sectional elevation of a spark plug.

Fig. 2 is an exploded view of the spark plug showing the different parts.

Fig. 3 is an enlarged elevational view of the spring member when in operative position.

Fig. 4 is an enlarged perspective view of one of the members.

Fig. 5 is an enlarged perspective view of the spring member.

Referring to the drawing, particularly to Fig. 1, a metallic shell member 10 is provided having an externally-threaded portion 11 positioned below an external shoulder 12 on the shell. The externally-threaded portion 11 is adapted to cooperate with an engine block (not shown) in which a spark plug is positioned during operation. The shell 10 is provided with a hexagonal portion 13 above the shoulder 12 for convenient manual manipulation in positioning the spark plug in the engine block.

Adjacent the extreme lower end of the threaded portion 11 a recess 14 is provided in which is positioned a ground electrode 15, preferably of the cloverleaf type, having three or more prongs cooperating with a center electrode 16 to form the spark gap of the spark plug. The electrode 15 may be brazed in the recess 14, or attached thereto in any other convenient manner. The center electrode 16 is positioned in a ceramic insulator 17, preferably of the alumina type, extending therethrough in a central bore terminating at the upper end in a terminal 18. The center wire 16 may be sealed in the center bore of the insulator 17 in any convenient manner, as, for example, by powder packing or the like. The insula-

tor 17 is provided with an enlarged portion 19 to provide a pair of external shoulders 20 and 21. The lower shoulder 20 is adapted to rest upon an internal shoulder 22 of the shell member 10, being preferably positioned within the externally-threaded portion 11. A gasket member 23 is positioned between the external shoulder 20 of the insulator 17 and the internal shoulder 22 to provide a seal therebetween. The gasket is preferably formed of nickel or soft iron, or any other suitable material.

The upper portion of the shell 10, adjacent the hexagonal portion 13 and above the external shoulder 12, is provided with an internally-threaded counterbore 24 which terminates in a second internal shoulder 25 in the shell 10 which is preferably positioned below the external shoulder 21 of the insulator. This allows the external shoulder 21 to project into the counterbore 24 as is clearly shown in Figs. 1 and 3.

Resting on the upper shoulder 21 of the insulator, a ring-like spring member 26 is provided having an aperture slightly smaller than the enlarged portion 19 of the insulator so as to rest upon the extreme outer portion of the shoulder 21 by means of a curved surface 26*a* formed between the central aperture and the lower face 26*b* of the ring-like member. The outside diameter of the ring-like member is slightly smaller than the diameter of the internally-threaded bore 24 so as to fit between the internal bore and the insulator 17. The ring-like spring member 26 is preferably made of Inconel, or other metals having similar characteristics. Positioned above the ring-like spring member 26, a second ring-like member 27 is provided (shown in position in Fig. 3), being preferably made of steel or the like, and provided with the flat upper surface which cooperates with the lower face 28 of an externally-threaded shielding sleeve 29 which will be described in greater detail hereinafter. The lower surface of the spring-like member 27 is given a tapered contour having the thickest portion 27*a* positioned adjacent its outer edge so as to contact the spring member 26 adjacent its perimetrical edge. The diameter of the spring member 26 is slightly smaller than the counterbore 24 so as to fit loosely therein, while the diameter of the ring-like member 27 is slightly larger than the spring member 26 and fits snugly into the counterbore 24 to center the insulator assembly in the shell 10.

The threaded portion of the metallic insulating sleeve 29 is adapted to engage with the internally-threaded counterbore 24 to advance the sleeve inwardly, by turning it with a wrench, engaging with a hexagonal portion 30 so as to apply force to the ring-like member 27 which, in turn, communicates force to the spring member 26 by the portion 27*a* which contacts the spring member adjacent its perimetrical edge. In this manner a distorting force can be applied to the spring member, causing the spring member to take a deflected position, as is most clearly shown in Fig. 3. The spring member 26, in turn, communicates the force, created by the threaded engagement, to the shoulder 21 of the insulator so as to thrust the lower shoulder 20 against the gasket 23 seated on the internal shoulder 22 of the shell. The gasket 23 is "coined" by this force to form an air-tight seal between the insulator 17 and the shell 10. At the same time the spring member 26, being distorted by the force, creates a resilient cushion between the insulator 17 and the shell 10 which is capable of compensating for the different rates of expansion of the metal shell and the ceramic insulator.

In controlling the foot-pounds of torque applied to the hexagonal portion 30 of the sleeve 29, the compressive force applied by the insulator 17 to the gasket 23 can be controlled within relatively close limits. It is essential that the compressive stress shall be maintained at a predetermined point which is sufficient to maintain a seal at the gasket 23 and not exceed a unit stress which will crush or cause breakage of the insulator at either of the shoulders 20 or 21. In order to maintain this pressure at the desired value, it is convenient to braze, or otherwise permanently attach the shielding sleeve 29 to the shell 10 at a point above the threaded relation between the two parts as is shown by a fillet 31. This creates a functionally-integral shell which originally comprised two parts, namely the shell 10 and the shielding sleeve 29.

As is clearly shown in Fig. 1, the upper portion of the insulator 17 extends a considerable distance into the sleeve 29 and terminates at substantially a central location by the terminal 18 of the center wire 16. To insulate the high tension electric current which is in an ignition circuit contacting the terminal 18 by means well known in the art (not shown), an insulating sleeve 32 is provided fitting inside of the shielding sleeve 29. The lower end of the insulating sleeve 32 rests upon a gasket member 33 resting on a shelf 34 formed by the upper surface of the ring-like member 27 while the upper end is in contact with another gasket 35 contacting an inturned flange 36 formed on the upper end of the shielding sleeve 29. The gaskets 33 and 35 may be of insulating material, such as asbestos or the like, or may be formed of metal if desired and are adapted to hold the insulating sleeve 22 firmly in position in the shielding sleeve 29. The insulating sleeve 32 may be positioned within the shielding sleeve 29 prior to the time the shielding sleeve is placed in threaded engagement with the internal counterbore 24 with the flange 36 already in position or, if desired, it may be inserted after the shielding sleeve 29 is already in cooperative relation with the counterbore 24, in which case the flange 36 must be turned in after the insulating sleeve 32 is inserted in position.

The upper portion of the sleeve 29 is provided with a threaded portion 37 which is utilized to connect shielding devices containing high tension leads which form a part of the ignition circuit of the engine in which the spark plug is to be used. This structure is well known in the art and need not be described in detail.

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 drawing, 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 device of the class described, a metallic shell having an internal shoulder and an insu-

lator including a central electrode positioned in the shell having an enlarged portion adapted to rest on the internal shoulder, a ring-like spring member adapted to cooperate with the enlarged portion of the insulator, the radial dimension of a portion of the spring member being substantially larger than its longitudinal dimension, and means on the shell to cooperate with the perimeter of the spring member to distort the spring member whereby the insulator is resiliently held against said internal shoulder.

2. In a device of the class described, a metallic shell having an internal shoulder and an insulator including a central electrode positioned in the shell having an enlarged portion adapted to rest on the internal shoulder, a ring-like spring member adapted to cooperate with the enlarged portion of the insulator and means cooperating with the shell and the perimeter of the spring member whereby the spring member may be subjected to a torsional stress of a predetermined amount for longitudinal deflection in its radial extent to hold the enlarged portion of the insulator resiliently against said internal shoulder of the shell.

3. In a device of the class described, a metallic shell having an internal shoulder and an insulator including a central electrode positioned in the shell having an enlarged portion adapted to rest on the internal shoulder, a relatively flat ring-like spring member resting on the enlarged portion of the insulator to extend outwardly therefrom, and means cooperating with the shell and the perimeter of the spring member whereby the spring member may be subjected to torsional stress of a predetermined amount for longitudinal deflection in its radial extent to hold the enlarged portion of the insulator resiliently against said internal shoulder of the shell.

4. In a device of the class described, a metallic shell having an internal shoulder and an insulator including a central electrode positioned in the shell having an enlarged portion adapted to rest on the internal shoulder, a ring-like spring member of substantially rectangular cross section resting on the enlarged portion of the insulator to extend outwardly therefrom, manually adjustable means on the shell to cooperate with the perimeter of the spring member to allow distortion of the spring member to a predetermined amount to resiliently urge the enlarged portion of the insulator against the internal shoulder of the shell.

5. In a shielded spark plug, a metallic shell having an internal shoulder with an externally-threaded end portion adjacent said shoulder and an internally-threaded portion on the opposite end of the shell, an insulator with a central electrode positioned in the shell having an enlarged portion adapted to rest on the internal shoulder, a ring-like spring member adapted to cooperate with the enlarged portion of the insulator adapted fit within the internal threaded portion of the shell, a second ring-like member of substantially the same diameter as the spring member positioned above the spring member having a portion adapted to cooperate with the outer edge of the spring member, an externally-threaded sleeve adapted to cooperate with the internal threads of the sleeve-like member to contact the second ring-like member to apply force upon both the second ring-like member and the spring member to distort the spring member, and an insulating sleeve positioned within the sleeve-like member positioned around the insulator.

6. In a shielded spark plug, a metallic shell having an internal shoulder and a threaded end portion adjacent the shoulder, an insulator with a central electrode positioned in the shell having an enlarged portion adapted to rest on the internal shoulder, a ring-like spring member of substantially rectangular cross section adapted to cooperate with the enlarged portion of the insulator and to fit within the shell, a shielding sleeve adapted to fit within the shell adjacent the spring member adapted to apply force to the spring member to distort the spring member to hold the insulator resiliently against said internal shoulder, means to attach the sleeve member to the shell member, an insulating sleeve positioned inside the shielding sleeve to surround the upper end of the insulator above the enlarged portion, and means to hold the insulating sleeve in position.

7. In a shielded spark plug, a metallic shell having an internal shoulder and an externally-threaded end portion adjacent such shoulder, an insulator having a center electrode positioned in the shell having an enlarged portion adapted to cooperate with the internal shoulder, a ring-like spring member adapted to fit within the metallic shell having a curved contour adapted to rest upon the enlarged portion of the insulator, a second ring-like member of substantially the same diameter as the spring member cooperating with the perimeter of the spring member, a shielding sleeve adapted to fit into the metallic shell adjacent the spring member to cooperate with the second ring member and adapted to apply a distorting force to the spring member through the agency of the second ring-like member, means to hold the shielding sleeve in position in the shell, and an insulating sleeve positioned between the shielding sleeve and the upper portion of the insulator resting upon the second ring-like member, and means to hold the insulating sleeve in position in the shielding sleeve.

8. In a device of the class described, a metallic shell having an internal shoulder and a ceramic insulator including a central electrode positioned in the shell with an enlarged portion of the insulator adapted to rest on the internal shoulder, a toroidal spring member of substantially rectangular cross section with its largest dimension positioned radially, said spring member having an arcuate surface at its inner lower edge to cooperate with the enlarged portion of the insulator, and means cooperating with the shell and the upper perimetrical edge of the spring member to subject said spring member to a torsional stress to hold the enlarged portion of the insulator resiliently against the internal shoulder of the shell.

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