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SPARK PLUG

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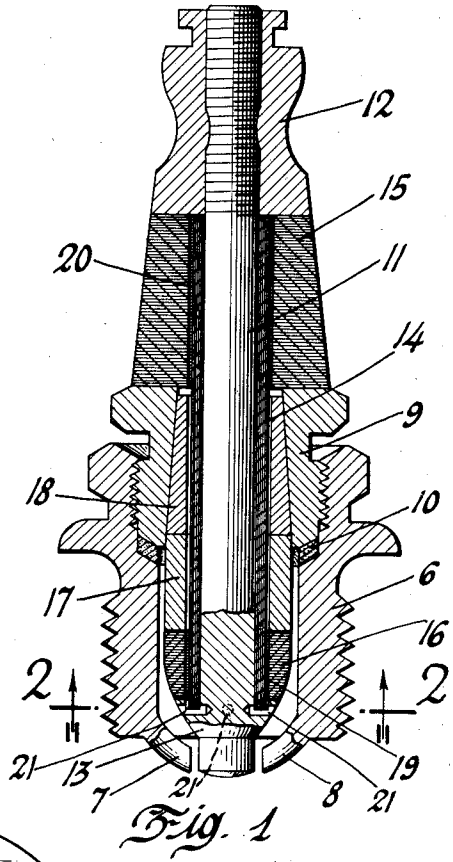


Fig. 1

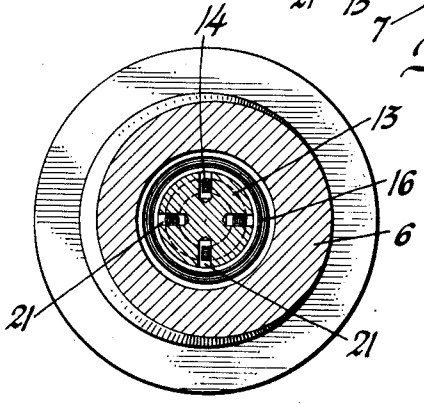


Fig. 2

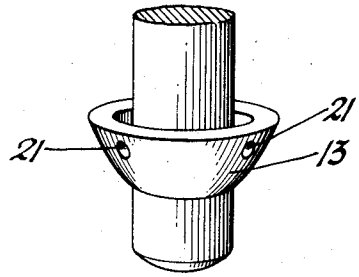


Fig. 3

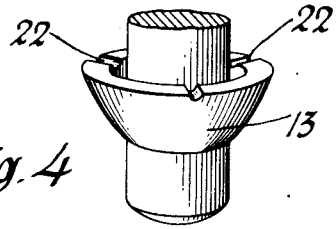


Fig. 4

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SPARK PLUG

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3 Claims. (Cl. 123—169)

Our invention relates to spark plugs for use with internal combustion engines, and more particularly to spark plugs designed for use with internal combustion engines wherein the pressure to which the combustible mixture within the engine cylinder is compressed to an inordinate degree prior to the ignition thereof. Such engines are commonly referred to as "high compression" engines. They are used particularly as airplane engines, and the insulating means for the central electrode of the plug is ordinarily made of mica.

In investigating spark plugs used with engines wherein the initial compression is inordinately high we have observed that there is often a failure to ignite the combustible mixture at starting which, however, ceases after a short time, and the plug may thereafter operate satisfactorily. This indicates improper sparking at the spark gap of the plug at starting such as follows leakage of current from the central electrode to the grounded shell of the plug, whereby the plug is short circuited to a greater or less degree; which leakage as our investigations prove is caused by gas inside the central electrode assembly and between the electrode proper and a metallic supporting member for removably supporting the central electrode assembly within the shell or casing of the plug; which supporting member in the type of plug herein involved is in direct metal to metal contact with the grounded shell of the plug. The gas within the interstices of the central electrode assembly is, at the starting of the engine, substantially at atmospheric pressure.

The object of our invention is therefore to provide for an equalization of the pressures at the spark gap and within the unavoidable gas filled space within the central electrode assembly (meaning the central electrode itself, the insulating means therefore, and the grounded metallic support for the electrode and the insulation) so that failure to ignite, or misfiring, will not occur at the starting of the engine; this equalization of pressures being brought about by a passage at the lower end of the central electrode which permits the pressure of the gas within the cylinder to be communicated to the gas contained within the interstices inside the central electrode assembly of the plug.

The drawing accompanying and forming a part of this application illustrates the preferred form of our invention, and the claims at the end of this specification enumerate the particular features wherein our invention consists. Our invention, however, may be embodied in various forms other than the particular form illustrated and hereinafter described, so long as such other forms come within the scope of the concluding claims.

In the drawing:

Figure 1 is an enlarged view showing a section upon a central plane extending longitudinally of a spark plug made in accordance with our invention.

Figure 2 is a view further enlarged, showing a section upon a transverse plane indicated by the line 2—2, Figure 1.

Figure 3 is a perspective view showing the lower end of the central electrode upon about the same scale as Figure 2.

Figure 4 is a perspective view similar to Figure 3, but showing a different method of providing the equalizing passage which enters into and forms a part of our invention.

Referring now to the drawing, the numeral 6 designates the metallic shell or casing of our improved spark plug which is adapted to screw into a threaded opening in an internal combustion engine cylinder wall, and 7 and 8 the grounded shell electrodes of the plug.

The central electrode assembly of the plug comprises a single unitary device separate from the shell or casing, and in the form of our invention herein disclosed the same is readily removable from the shell as a unit, and as readily replaceable therein; although the same may be permanently assembled with the shell or casing as in so-called single piece spark plugs.

As shown the central insulated electrode assembly is supported within the metallic shell or casing of the plug by an annular metallic supporting member, which is preferably in the form of a gland nut 9 which screws into the threaded upper end of the interior of the shell; a metallic packing gasket 10 being ordinarily placed between the lower end of said gland nut and an internal shoulder of the shell. This gland nut is in direct metal to metal contact with the shell and is therefore grounded as will be seen.

The central electrode of our improved spark plug is designated by the numeral 11, the same having a terminal connector 12 at its outer end and a head 13 at its inner end, a part of this head being disposed adjacent the shell electrodes to provide a spark gap as will be understood. This central electrode extends through the annular metallic support provided by the gland nut 9, and is insulated therefrom by insulating means which may be of various forms. In the embodiment of our invention illustrated insulation for the central electrode is provided by a tubular insulating member 14 made of sheet mica which

surrounds said electrode and extends throughout the length thereof, and by insulating members 15, 16 made up of stacks of mica washers which last-named insulating members surround the ends of the tubular insulating member 14. The upper insulating member is arranged between the upper side of the gland nut 9 and the underside of the head 12, and the lower one between the upper side of the head 12 and the underside of said gland nut. A metallic bushing 17 is preferably interposed between the upper end of the lower insulator and the lower end of a metallic sleeve 18 which surrounds the tubular insulating member 14 and fits within a seat provided for it within the gland nut. The bushing 17, sleeve 18, insulating members 14, 15 and 16, and the gland nut 9 therefore provide a support for the central electrode 11 as will be appreciated.

The parts which form the central electrode assembly are preferably assembled under pressure applied to the terminal connector 12 and the head 13 and acting longitudinally of the central electrode, and are held in assembled relation by collapsing the interior of the connector against the upper end of said electrode while the pressure which holds the parts together is maintained, all in substantial accordance with United States patent for Method of forming mica insulated spark plugs, No. 1,872,497, August 16, 1932; during which assembling the terminal connector is heated by a current of electricity the volume of which is preferably sufficient to accomplish the welding of the same to the electrode. The pressure equalizing feature of our invention, however, is in no way dependent upon the particular way in which the parts which comprise the central electrode assembly are assembled and held together to form a unitary structure.

While in a central electrode assembly made up of the parts enumerated the total volume of unavoidable unfilled space, or interstices, between the electrode itself and the gland nut or equivalent grounded support, and which interstices are variously and indefinitely distributed within the confines of the said assembly, is very small, there is nevertheless an appreciable space within the assembly which is or becomes filled with gas, and which gas offers much less resistance to leakage of current than would be the case if no such gas-filled space was present. For example, it is impossible to secure perfect contact between the lower insulator 16 and the lower end of the tubular insulator 14, and there is therefore an appreciable gas containing space, as at 19, between said members which forms a path of less resistance to leakage of high tension current from the head 13 to the bushing 17, sleeve 18, gland nut 9 and to the casing of the plug, than would be the case if said space 19 was not present; and the same applies to a similar but longer gas containing space at 20 between the upper insulator 15 and the upper end of said tubular insulator, leakage through this gas filled space being from the terminal connector 12 to the sleeve 18, gland nut 9 and likewise to the casing of the plug.

The sum total of the interstices within the confines of the central electrode assembly therefore contain an appreciable quantity of gas which provides a path of much less resistance to the flow of high tension current than mica or any of the insulating materials usually employed in spark plugs would provide, were the interstices completely filled with insulating material. If the plug sparks properly at atmospheric pressure, or if it is used in an engine employing only moderate compression, the high resistance of the path provided by the gas within the interstices, together with its considerable length, will ordinarily prevent leakage to an extent sufficient to reduce the current at the spark gap below that required for ignition of the combustible mixture. When, however, such plugs are used in high compression engines the gas pressure at the spark gap is often sufficient to prevent the high tension current from jumping the gap (this because the resistance of a gas increases as its pressure increases) and short circuiting through the gas filled interstices, or excessive leakage such as to greatly reduce the current at the gap, will occur; the result in either case being misfiring of the plug and a failure to ignite the combustible mixture within the engine cylinder.

Our invention therefore aims to secure a gas pressure within the interstices aforesaid sufficiently high to insure that the flow of current shall be (disregarding unavoidable leakage) across the spark gap, rather than through the gas within the interstices of the central electrode assembly, and to secure that result as quickly as possible upon the starting of the engine. Leakage through the lower insulating member 16 and along the joints between the ends thereof and the head 13 and bushing 17 will sometimes result in the building up of pressure within the interstices, but this will be a slow process and an object of our invention is to build up such pressure instantly, or within an extremely short time. Furthermore, the better a plug is made the less will be the leakage of gas above referred to, so that our invention is of particular importance in high grade plugs designed for use with airplane engines.

The building up of pressure within the interstices of the central electrode assembly is secured by providing the lower end of the central electrode with a passage, which we call an "equalizing passage", the outer end of which is in open communication with the interior of the engine cylinder when the plug is in use, and the inner end of which communicates with said interstices. This passage may be variously provided and arranged. Thus in Figures 1, 2 and 3 one or more very small holes 21 are provided in the head 13 the inner ends of which terminate below the lower ends of the tubular electrode 14 and the space 19. The interstices within the central electrode assembly communicate with one another and form in effect one single space or cavity so that pressure reaching any part of the gas chamber thus provided is equalized throughout the entire space formed by the interstices whatever their location and disposition may be.

There is little or no actual flow of gas through the passage 21 as the total volume of the interstices is minute, and the cross-sectional area of said passage may be as small as the smallest drill available for its formation, so long as its diameter and arrangement is such that it will not be likely to become clogged by oil or carbon deposit when the plug is in use. Figure 4 shows a construction wherein the equalizing passage or passages are provided by grooves 22 formed in the shoulder of the head 13 which supports the lower end of the insulating member 16.

However the equalizing passage is provided it is obvious that pressure inside the engine cylinder is communicated to the gas within the interstices of the central electrode assembly, thus building up a gas pressure therein which approaches the maximum pressure within the cylinder; and

which will always be sufficiently high to prevent short circuiting of the plug or leakage of current to an extent sufficient to interfere with the operation thereof. The actual flow of gas through the equalizing passage will be slight as hereinbefore explained but, and because of the presence of a definite passage even though its diameter is very small, the equalizing action will take place without appreciable delay as the pressure due to compression of the mixture inside the engine cylinder approaches its maximum, so that there will be no failure of the plug to ignite the combustible mixture even though at starting the pressure within the interstices will be atmospheric pressure.

Having thus described and explained our invention we claim and desire to secure by Letters Patent:

1. In a spark plug and in combination with the metallic shell or casing thereof, a central electrode having a terminal connecter at its outer end, and an enlarged head at its inner end; means including insulating members and annular metallic members surrounding said electrode for supporting said electrode within said shell, and which metallic members are in contact with one another and one of which is in direct metal to metal contact with the metallic shell or casing of the plug; said central electrode having an equalizing passage adjacent its inner end whereby pressure inside an engine cylinder, and pressure within interstices between said electrode and said supporting means, are equalized when the plug is in use.

2. In a spark plug and in combination with the metallic shell or casing thereof, a central electrode having a terminal connecter at its outer end, and an enlarged head at its inner end; insulating means and annular metallic means surrounding said electrode, and which means together serve to support said electrode within said shell, said annular metallic means being in direct metal to metal contact with the metallic shell or casing of the plug; said central electrode having an equalizing passage adjacent its inner end whereby pressure inside an engine cylinder, and pressure within interstices between said electrode and said supporting means, are equalized when the plug is in use.

3. In a spark plug and in combination with the metallic shell or casing thereof, a central electrode having a terminal connecter at its outer end, and the inner end of which terminates adjacent an electrode carried by the shell or casing of the plug; insulating means and annular metallic means surrounding said electrode, and which means together serve to support said electrode within said shell, said annular metallic means being in direct metal to metal contact with the metallic shell or casing of the plug; said central electrode having an equalizing passage adjacent its inner end whereby pressure inside an engine cylinder, and pressure within interstices between said electrode and said supporting means, are equalized when the plug is in use.

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