Sept. 21, 1954 W. B. SMITS 2,689,556

SURFACE DISCHARGE SPARK PLUG FOR LOW VOLTAGES AND CONDENSER DISCHARGE

Filed July 31, 1951 2 Sheets-Sheet 1

Fig. 1.

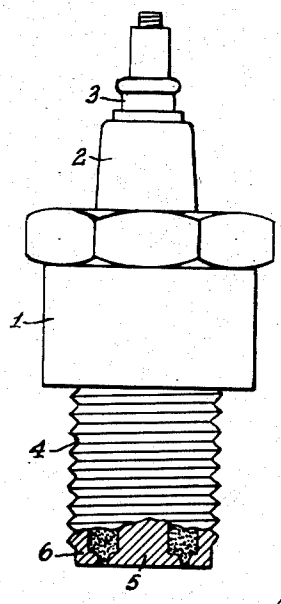


Fig. 2.

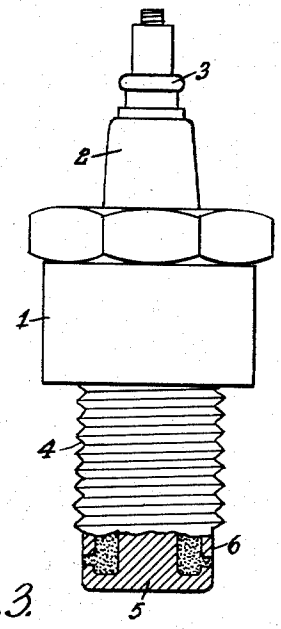
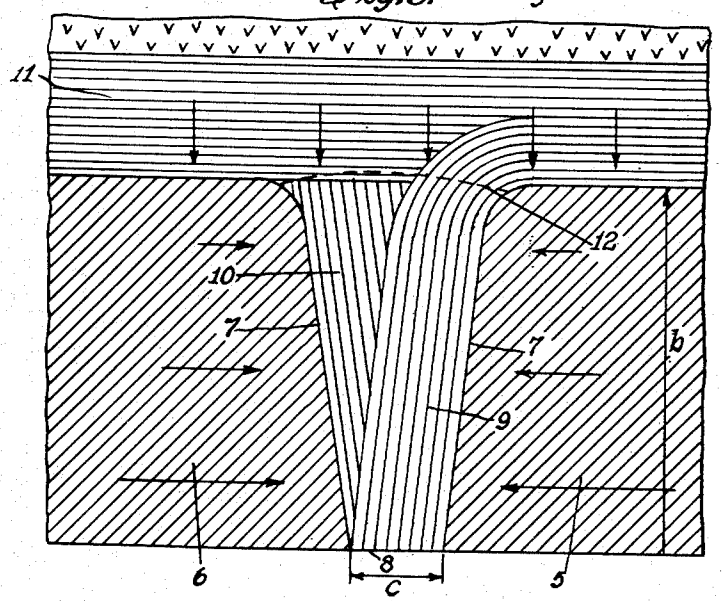


Fig. 3.



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Filed July 31, 1951 2 Sheets-Sheet 2

Fig. 4.

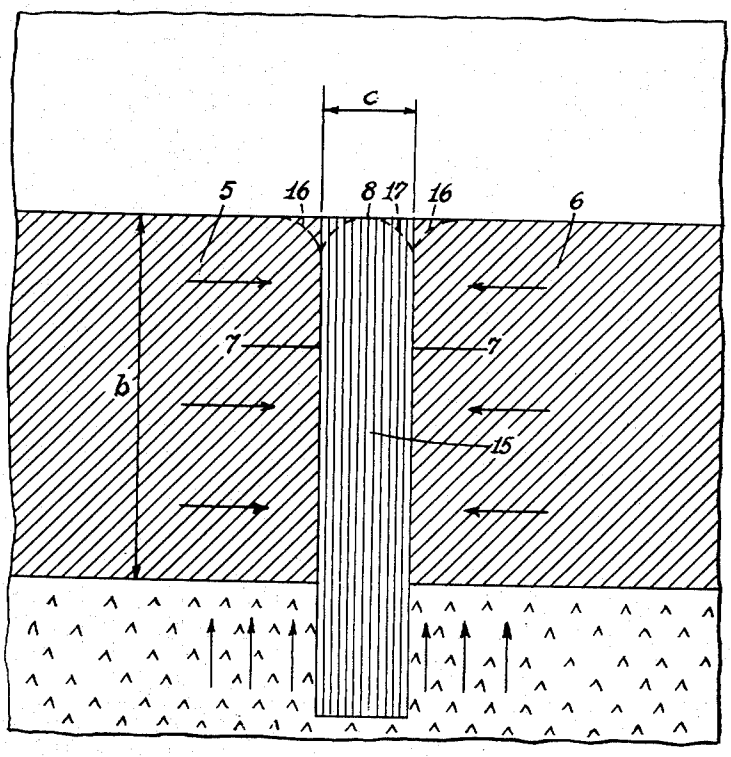
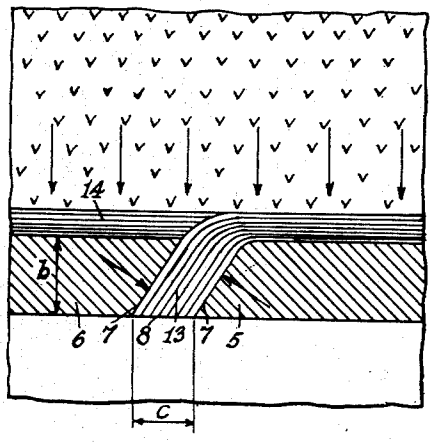


Fig. 5.



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SURFACE DISCHARGE SPARK PLUG FOR LOW VOLTAGES AND CONDENSER DISCHARGE

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Application July 31, 1951, Serial No. 239,577

4 Claims. (Cl. 123—169)

1

The invention relates to a surface discharge spark plug for low voltages and condenser discharge, in which plug there is arranged between the electrodes a separating body, over the free active surface of which the spark is formed.

Such a plug is known from the Netherlands Patent Specification No. 62,644.

From Fig. 3 of said specification it appears to be known to make the thickness, or the smallest thickness, of the electrodes, measured downwards, perpendicularly to the active surface, small in proportion to the shortest distance between these electrodes. From Fig. 1 of the said specification, however, a similar plug is known in which this thickness of the electrodes is comparatively great.

Plugs with a small proportion between these distances have the advantage that upon continued erosion and wear of the separating material, at a given place between the electrodes a fairly sharp limit is set to the depth of erosion, when the separating material has been eroded to the depth of the electrodes.

In fact, when the erosion continues a little further, the spark gap between the electrodes, and consequently the resistance, will become too great to enable the passage of the flame spark at this place. This has the advantage that the flame spark cannot be formed at great depth between the electrodes at this place, as a result of which it would fail to have a satisfactory effect on the gas mixture to be ignited. Before the depth of erosion becomes so great that the ignition would no longer be satisfactory and the plug would have reached the end of its life, the flame spark is therefore forced to form at a place where the resistance is less and which consequently has not yet been eroded so much. Thus a long life is ensured, because the separating material may be eroded everywhere throughout the depth between the electrodes before the plug becomes unusable.

Now it has been found that in the known plugs with small thickness of the electrodes the erosion of the material of the separating body still takes place rather quickly and irregularly.

The boundary of the erosion at reaching the limit of depth of the electrodes is also often very irregular.

Now it was found that such known plugs yield better results in this respect, if according to the invention the proportion between the thickness, or the smallest thickness, of the electrodes, measured downwards perpendicularly to the active surface, and the shortest distance between the

2

electrodes is taken less than or equal to four and the separating body is under pressure between the electrodes.

It is known per se to bring a permanent pressure to bear on the material of the separating body in surface discharge spark plugs; in fact, plugs in which this is the case were on view at an exhibition held in September 1949 at Farnsborough, England under the auspices of the Society of British Aircraft Constructors (vide the catalogue of this exhibition, entitled "Exhibition and Flying Display," pp. 38 and 39, published by the British Ministry of Supply).

In order to eliminate in particular the irregularity of the erosion boundary even further, it is suggested that, in addition to the measures described, a pressure be also brought to bear on the deeper part of the separating body, if the latter also extends beyond the electrodes.

This effect is improved even more when this pressure beyond the electrodes is mainly directed perpendicularly to the active surface of the separating body.

Any additional features and advantages will become apparent from the following description of some embodiments illustrated in the drawings.

Fig. 1 illustrates a surface discharge spark plug according to the invention in front view, with part of it in cross-section.

Fig. 2 illustrates another embodiment of a spark plug, also according to the invention.

Fig. 3 is a cross-section on an enlarged scale of the area of the plugs according to Figs. 1 and 2.

Figs. 4 and 5 illustrate on an enlarged scale two other possible embodiments of the areas of such plugs.

The plugs according to Figs. 1 and 2 comprise, as usual, a casing **1**, an insulator body **2**, and a connecting terminal **3**. The casing **1** has a screw-threaded extension **4**, by means of which the plug can be screwed, for example, into the cylinder lid of an internal combustion engine or the like, electric contact with the mass being established via the screw thread.

As is shown in cross-section in Figs. 1 and 2, the screw-threaded extension **4** of the casing **1** enclosed an inner electrode **5**, while the said screw-threaded extension **4** passes into an annular outer electrode **6** surrounding the inner electrode **5**. The space between the electrodes **5** and **6** is filled up completely or partially with a separating body of non-conductive material.

The difference between the plugs according to

Figs. 1 and 2 consists in that according to Fig. 1 the active parts of the electrodes and the separating body lie in the bottom face of the plug, perpendicularly to its axis, while in Fig. 2 these active parts lie on the circumference of a cylinder.

Fig. 3 illustrates how the boundary lines 7 between the electrodes 5 and 6 and the separating body, viewed in a plane perpendicular to the active surface 8 of the spark plug, converge towards this active surface. The electrodes have a thickness, measured perpendicularly to the active surface 8, which is designated by *b*, the proportion between this thickness and the shortest distance *c* of the electrodes being less than or equal to four.

The separting body consists, between the electrodes, of stratified material, for example of mica, asbestos which has been prepared and combined into thin layers, or the like. These thin layers are designated by 9 and 10 in Fig. 3. The layers 9 are parallel to the flank 7 of the electrode 5, and these layers extend beyond the electrodes. Where they emerge from the space between the electrodes 5 and 6, these layers 9 are bent round the electrode 5, after which they extend parallel thereto.

The layers 10 are parallel to the flank 7 of the electrode 6, and fill up further the space between the electrodes. Beyond the electrodes the separating body consists of a number of thin layers 11, which are parallel to the active surface 8 of the plug. Further beyond these layers 11 the separating body consists of nonstratified material.

Apart from the given proportion *b/c*, which is to be less than or equal to 4, the invention mainly consists in that the separating body is under pressure between the electrodes. This pressure is indicated by arrows in Fig. 3. As illustrated, the pressure exerted is greater in places which are nearer the active surface. As may be seen from this figure, the sparating body is also under pressure beyond the electrodes.

As has been explained in the preamble of the specification, a particularly long life and a favourable distribution and retardation of the erosion of the material of the separating body is thus obtained. The extent to which the separating body is eroded is determined by the increase of the resistance occurring when erosion takes place. If the resistance becomes too great, a flame spark can no longer be formed between the electrodes. The erosion boundary is roughly indicated by the dotted line 12 in Fig. 3. The stratified material between the electrodes has great resistance to erosion, and when the line 12 has been reached, the flame spark is further largely formed along the layers 11. Since these are flat, they have great resistance to erosion, so that a fairly long time elapses before the erosion has proceeded to any appreciable extent. Owing to this circumstance the plug continues sparking in this place for a considerable time before the resistance has become so great that a spark is no longer formed. The fact that the layers 11 are also under pressure, which pressure is preferably directed mainly perpendicularly to the active surface 8, as shown by arrows in Fig. 3, causes this advantage to appear in an even more marked degree.

In the embodiment according to Fig. 4 the adjacent flanks of the electrodes 5 and 6, which flanks are designated by 7 again, are parallel to each other and perpendicular to the active surface 8 of the plug. In this case the separating body consists, between the electrodes 5 and 6, of stratified material 15, and the layers of this material extend into the separating body across a distance beyond the electrodes. As illustrated, the separating body consists of non-stratified material beyond the electrodes. The arrows in this figure show how the separating body is under pressure both between and beyond the electrodes. The lines of dashes (16 and 17) indicate the approximate shapes which the electrodes and the separating body will have when the plug has been used for some time. The proportion *b/c* is less than four again in this case.

Fig. 5 illustrates a different embodiment, in which the flanks 7 of the electrodes 5 and 6 are parallel and slant in relation to the active surface 8 of the plug. In this case again the separating body is under pressure between the electrodes, while the distance *c* in proportion to the distance *b* is such that *b/c* is less than or equal to four. In this embodiment the separating body consists, between the electrodes, of thin layers 13, which extend beyond the electrodes and which are bent round in this deeper portion until they are parallel to the active surface 8. Thin layers 14, parallel to the active surface 8, lie against the electrode 6 and are connected with the layers 13 where the latter are bent round. Beyond the electrodes the separating body again consists, beyond the layers 13 and 14, of non-stratified material. As indicated by arrows in this figure, the material of the separating body in this embodiment is again under pressure both between the electrodes 5 and 6 and beyond these electrodes.

This embodiment has the additional advantage that the layers 13 need only be bent round through a small angle, so that they will tear less readily at the place where they are bent, while the pressure may be brought to bear on the separating material between the electrodes by simply impressing the edges of the electrode 5.

When the material of the separating body is of such a nature that this pressure is not propagated uniformly in all directions, the pressure exerted on the separating body beyond the electrodes is preferably directed mainly perpendicularly to the active surface of the separating body, as shown by arrows in the Figs. 3 to 5 inclusive. However, the separating body might also not be under pressure at all beyond the electrodes, though it is preferred to bring such pressure to bear on it. The pressure in the separating body between the electrodes may be the same throughout, but is preferably so distributed that the pressure is greatest near the active surface, as is clearly shown by arrows in Fig. 3.

The material of the separating body need not be stratified between the electrodes, but it has been found that in many cases stratification is to be preferred.

Naturally the active surface need not extend in a circle between the electrodes. The active edges of the electrodes might also be star-shaped or otherwise. It is also possible to use more than two electrodes electrically connected in pairs, which electrodes have active edges in the shape of, for example, concentric figures.

I claim:

1. A surface discharge spark plug for operation with a condenser discharge in low-tension ignition installations comprising, in combination, a plurality of electrodes and an insulating body separating the electrodes and providing a free surface for the sliding passage of the sparks

between the electrodes, a portion of said insulating body being disposed between the electrodes and being continuously under positive pressure in a direction substantially parallel to said surface and a portion of said insulating body being disposed behind the electrodes relative to said surface, and said last-named portion being continuously under a positive pressure in a direction substantially perpendicular to said surface.

2. A surface discharge spark plug as defined in claim 1, wherein the pressure on the portion of said insulating body lying between said electrodes is greatest adjacent said surface.

3. A surface discharge spark plug for operation with a condenser discharge in low-tension ignition installations comprising, in combination, a plurality of electrodes and an insulating body formed from laminated non-conductive material separating the electrodes and providing a free surface for the sliding passage of the sparks between the electrodes, said insulating body having a portion disposed between the electrodes and a portion disposed behind the electrodes relative to said surface, the laminated non-conductive material of said insulating body being disposed at an oblique angle relative to said surface in the portion of said body between said electrodes and diverging in said portion away from said surface, the portion of said body between said electrodes being under a pressure substantially parallel to said surface and the portion of said body behind said electrodes being under a pressure substantially perpendicular to said surface.

4. A surface discharge spark plug for operation with a condenser discharge in low-tension ignition installations comprising, in combination, a plurality of electrodes and an insulating body formed from laminated non-conductive material separating the electrodes and providing a free surface for the sliding passage of the sparks between the electrodes, said laminated insulated body having a portion disposed between the electrodes with at least some of the laminae of the laminated non-conductive material between the electrodes extending inwardly from said surface for a greater distance than do said electrodes and being bent around the inner ends of the electrodes into a position substantially parallel to said surface to form a portion of said insulating body substantially parallel to said surface disposed behind the electrodes relative to said surface.

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