June 13, 1944. H. H. RACE 2,351,543

ELECTRICAL DISCHARGE DEVICE

Filed May 2, 1942

Fig. 1.

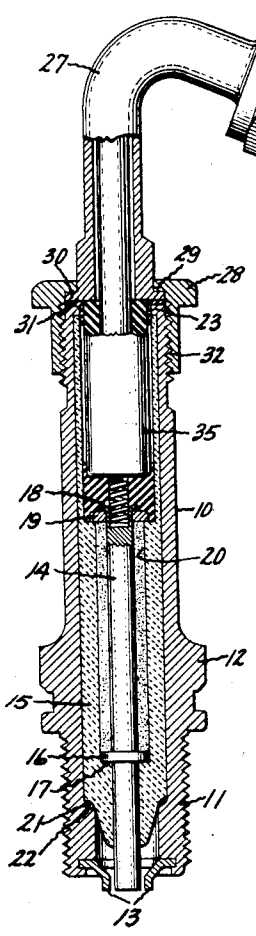


Fig. 2.

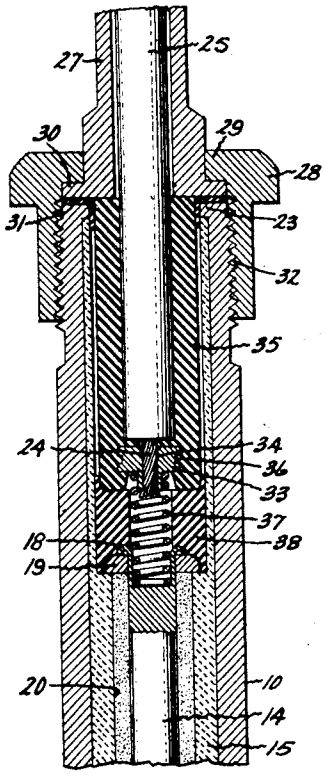


Fig. 3.

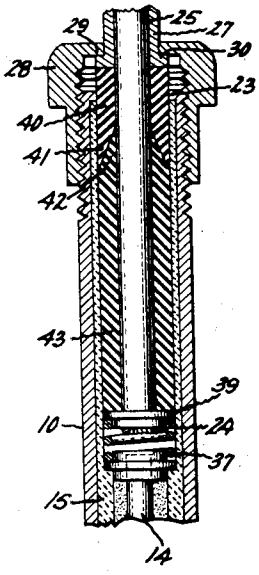


Fig. 4.

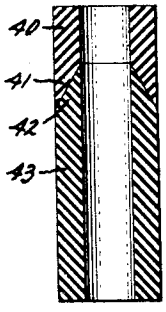
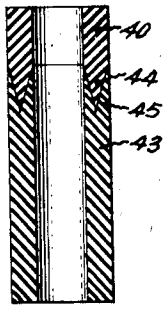


Fig. 5.



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Patented June 13, 1944 2,351,543

UNITED STATES PATENT OFFICE

2,351,543

ELECTRICAL DISCHARGE DEVICE

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Application May 2, 1942, Serial No. 441,501

7 Claims. (Cl. 315—326)

My invention relates to spark plugs.

An object of my invention is to provide an improved spark plug having a construction which minimizes the possibility of flash-over within the plug by substantially eliminating gas electrical discharge paths between the distribution lead and the shell of the plug.

Further objects and advantages of my invention will become apparent and my invention will be better understood from the following description referring to the accompanying drawing, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

In the drawing, Fig. 1 is an elevational view, partly in section, of a spark plug and a distribution lead provided with an embodiment of my invention; Fig. 2 is an enlarged sectional view of the upper portion of the spark plug and its connection to the distribution lead shown in Fig. 1; Fig. 3 is a modification of the construction shown in Figs. 1 and 2; Fig. 4 is an enlarged view of the resilient bushing and non-deformable cap shown in Fig. 3; and Fig. 5 is a modification of the bushing and cap shown in Figs. 3 and 4.

Referring to the drawing, I have shown a spark plug provided with an outer metallic sleeve or barrel 10 and threaded at one end 11 for engagement with a complementary threaded opening in an engine block and having an enlarged portion 12 adapted to be engaged by a wrench or similar tool. Grounding electrodes 13 are secured to the shell 10 adjacent the lower threaded end 11 and a central or discharge electrode 14 is supported within the spark plug by a ceramic insulating core 15 of porcelain or similar material. The discharge electrode 14 is formed with a lower flange 16 which engages a complementary shoulder 17 on the insualting core 15 and is provided with a turned-over contact head portion 18 which secures a cap 19 in position over a central opening 20 in the insulating core 15. This central opening 20 in the core 15 between the electrode flange 16 and the cap 19 is filled with a body of compressed or compacted powder. The core 15 is held in position in the shell 10 by engagement adjacent its lower end with a gasket 21 seated on a shoulder 22 formed on the shell 10 and by engagement at the opposite end thereof with a turned-over end 23 of the shell 10.

The desired electrical potential is brought to the central electrode 14 by a distribution lead 24 of electrically conductive material which is insulated by a suitable flexible insulating covering 25 about which an armored metallic shield 26 is arranged. The distribution lead is held in position on the spark plug by a terminal elbow 27 which is secured to the head of the spark plug shell 10 by a threaded nut 28 provided with an annular flange 29 which extends over a complementary flange 30 on the elbow 28 and secures the elbow flange 30 against a heat resistant bushing 31 of deformable resilient material such as a high molecular weight polybutene or a mixture of polystyrene with polyisobutylene which is prepared as the composition described in British Patent No. 513,630 (1939), which is arranged between the flange 30 and the upper end 23 of the shell 10. These are all resiliently held together by the threaded engagement of the nut 28 with threads 32 formed on the adjacent upper end of the spark plug shell 10. In order to assure good electrical contact between the spark plug central electrode 14 and the distribution lead 24, a terminal connector is provided which includes an electrically conductive bushing 33 having a central passage 34 formed therein through which an end of the distribution lead 24 is threaded and is securely held by spreading the outer ends of the conductors of the lead 24 over the end of the bushing 33. This bushing is held in position in an insulating sleeve element 35 of relatively non-deformable material such as fiber and is securely anchored thereto by an annular flange 36 which is molded in the sleeve 35 and which extends into a complementary groove formed on the outer peripheral surface of the bushing 33. A contact comprising a coil spring 37 is arranged over the end of the bushing 33 and extends from the adjacent end of the insulating sleeve 35 into contact with the upper adjacent end of the central discharge electrode 14.

Under certain atmospheric conditions, such as relatively low pressure, there is a tendency for the voltage to discharge from the lead to the grounded plug shell through any gas discharge path. In order substantially to eliminate corona discharges and arc-over between the spark plug 10 and the electrical connection of the distribution lead 24 with the central discharge electrode 14, I provide a heat resistant bushing 38 of deformable resilient insulating material like bushing 31 arranged within the shell between the end 23 of the shell and the electrical connection of the lead 24 with the discharge electrode 14 within the insulating element 15. This deformable bushing is pressed into deformed position by engagement of the lower end of the terminal mem-

ber insulating sleeve 35 for substantially filling a circumferential portion of the space about the lead connection and sealing the space between the lower end of the terminal member and the shell, thereby substantially eliminating free open gas electrical discharge paths between the lead and the shell. When this bushing is deformed in this manner, a part of the upper portion thereof extends upwardly around the insulating sleeve 35 about the lead 24 and seals the air space between the lead connection and the upper resilient bushing 31, thereby effectively minimizing the tendency toward corona discharges through the air space between the lead connection and the upper end of the shell. The two bushings 31 and 38 are securely held in their deformed positions by tightening the nut 28 on the upper end of the shell 10, as this biases the elbow 27 into tight engagement with the upper portion of the bushing 31 and with the upper end of the insulating sleeve 35, thereby biasing this sleeve into tight engagement with the upper end of the bushing 38.

A modification of this construction is shown in Fig. 3 wherein the discharge portion of the spark plug is formed of substantially the same elements as those shown in Figs. 1 and 2, and includes a discharge electrode 14 arranged in the central opening of an insulating element 15 of ceramic material secured within the spark plug shell 10 and retained in position therein by the upper turned-over end 23 of the shell 10. In this construction, the distribution lead 24 and its surrounding insulation 25 extends into the spark plug shell 10 and is provided with a terminal washer 39 of electrically conductive material secured to the turned-over ends of the distribution lead 24. The distribution lead 24 is electrically connected with the central discharge electrode 14 by a coil spring 37 of electrically conductive material. In this construction, the flange 30 of the terminal elbow 27 is arranged in engagement with a relatively non-deformable cap element 40 of insulating material and with the complementary flange 29 formed on the upper end of the threaded nut 28 which threadedly engages the upper end of the spark plug shell 10. The cap 40 is provided with an inwardly tapered wedge-shaped lower portion 41 arranged in engagement with a complementary wedge-shaped upper portion 42 of a heat resistant bushing 43 formed of deformable resilient insulating material like bushing 31. This bushing 43 is arranged about the lead 24 and its insulation 25 within the shell 10 between the electrical connection of the lead 24 to the electrode 14 and the upper end of the shell 10. When the nut 28 is secured in position, it draws the flange 30 of the terminal elbow 27 downwardly into engagement with the upper end of the cap 40 which compresses and deforms the bushing 43 and substantially circumferentially fills a longitudinal portion of the space about the lead within the shell between the terminal washer 39 and the upper end of the shell, thereby eliminating free open gas electrical discharge paths between the shell and the lead, thus effectively sealing the space between the shell and the terminal connection 39 similar to the pair of bushings in the construction shown in Figs. 1 and 2. The deformable resilient bushing 43 and relatively non-deformable cap 40 are shown in detail in Fig. 4.

This deformable bushing and relatively non-deformable cap construction may be formed with a double conical wedge engaging surface as shown in Fig. 5 wherein the non-deformable cap 40 is provided with a V-section wedge end portion 44 which engages the upper end of the deformable resilient bushing 43 and extends into a complementary V-groove 45 in the upper end of the resilient bushing 43. This bushing and cap construction may be used in a spark plug as shown in Fig. 3.

While I have illustrated and described particular embodiments of my invention, modifications thereof will occur to those skilled in the art. I desire it to be understood, therefore, that my invention is not to be limited to the particular arrangements disclosed, and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A spark plug including a shell having a grounding electrode, a discharge electrode arranged within said shell, means including an insulating element arranged about a part of said discharge electrode in said shell for supporting said electrode, a lead of conductive material electrically connected to said discharge electrode within said insulating element, a heat resistant bushing of deformable resilient insulating material arranged within said insulating element between said shell and said electrical connection of said lead to said discharge electrode, and means including a relatively non-deformable insulating element arranged about said lead in engagement with said deformable bushing deforming said bushing for substantially filling a portion of the space about said lead connection for eliminating free open gas electrical discharge paths between said lead and said shell.

2. A spark plug including a shell having a grounding electrode, a discharge electrode arranged within said shell, an insulating element arranged between a part of said discharge electrode and said shell, a lead of conductive material electrically connected to said discharge electrode within said shell, a heat resistant bushing of deformable insulating material arranged between said shell and said electrical connection of said lead to said discharge electrode, means including a relatively non-deformable insulating element arranged in engagement with said deformable bushing deforming said bushing for substantially filling a portion of the space about said lead connection for eliminating free open gas electrical discharge paths between said lead connection and said shell, a second deformable insulating bushing arranged between said shell and said insulating element, and means deforming said second bushing for sealing the space between said shell and said first-mentioned bushing.

3. A spark plug including a shell having a grounding electrode, a discharge electrode arranged within said shell, an insulating element arranged between a part of said discharge electrode and said shell, a lead of conductive material electrically connected to said discharge electrode within said shell, insulation arranged about said lead and extending within said shell about a portion of said lead, a heat resistant bushing of deformable insulating material arranged between said shell and said electrical connection of said lead to said discharge electrode, means including a relatively non-deformable element arranged in engagement with said deformable bushing deforming said bushing for

substantially filling a portion of the space about said lead connection for eliminating free open gas electrical discharge paths between said lead and said shell, a second deformable insulating bushing arranged between said shell and said lead insulation, and means deforming said second bushing for sealing the space between said shell and said first-mentioned bushing.

4. A spark plug including a shell having a grounding electrode, a discharge electrode arranged within said shell, an insulating element arranged between a part of said discharge electrode and said shell, a distribution lead of conductive material electrically connected to said discharge electrode within said shell, insulation arranged about said lead and extending within said shell about a portion of said lead, a heat resistant bushing of deformable insulating material arranged between said shell and said electrical connection of said lead to said discharge electrode, means including a relatively non-deformable terminal member arranged in engagement with said deformable bushing deforming said bushing for substantially filling a portion of the space about said lead connection and sealing the space between one end of said terminal member and said shell for eliminating free open gas electrical discharge paths between said lead and said shell, a second deformable bushing of resilient insulating material arranged between said shell and said terminal member, and means deforming said second bushing for sealing the space about said terminal member between said shell and said first-mentioned bushing at the other end of said terminal member.

5. A spark plug including a shell having a grounding electrode, a discharge electrode arranged within said shell, an insulating element arranged between a part of said discharge electrode and said shell, a distribution lead of conductive material electrically connected to said discharge electrode within said shell, a heat resistant bushing of deformable resilient insulating material arranged between said shell and said electrical connection of said lead to said discharge electrode, means including a relatively non-deformable terminal member extending about a portion of said lead and arranged in engagement with said deformable bushing deforming said bushing for substantially sealing the space between one end of said terminal member and said shell for eliminating free open gas electrical discharge paths between said lead and said shell, a second deformable bushing of resilient insulating material arranged between said shell and said terminal member, and means deforming said second bushing for sealing the space about said terminal member between said shell and said first-mentioned bushing at the other end of said terminal member.

6. A spark plug including a shell having a grounding electrode, a discharge electrode arranged within said shell, an insulating element arranged between a part of said discharge electrode and said shell, a distribution lead of conductive material electrically connected to said discharge electrode within said shell, a heat resistant bushing of deformable resilient insulating material arranged within said shell about a portion of said lead, and means including a relatively non-deformable element having a wedge-shaped portion arranged in engagement and extending within an end of said deformable bushing for deforming said bushing providing good contact between said bushing and the adjacent surfaces on each side thereof and substantially filling a longitudinal portion of the space about said lead within said shell eliminating free open gas electrical discharge paths between said shell and said lead.

7. A spark plug including a shell having a grounding electrode, a discharge electrode arranged within said shell, an insulating element arranged between a part of said discharge electrode and said shell, a distribution lead of conductive material electrically connected to said discharge electrode within said shell, a heat resistant bushing of deformable resilient insulating material arranged within said shell about a portion of said lead, and means including a relatively non-deformable element having a wedge-shaped portion arranged in engagement with said deformable bushing for deforming said bushing and substantially filling a coaxial portion of the space about said lead within said shell eliminating free open gas electrical discharge paths between said shell and said lead.

HUBERT H. RACE.