May 21, 1957 N. E. HARPER 2,793,308

SPARK PLUG

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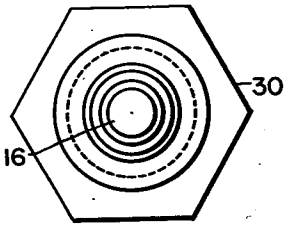


FIG. 3.

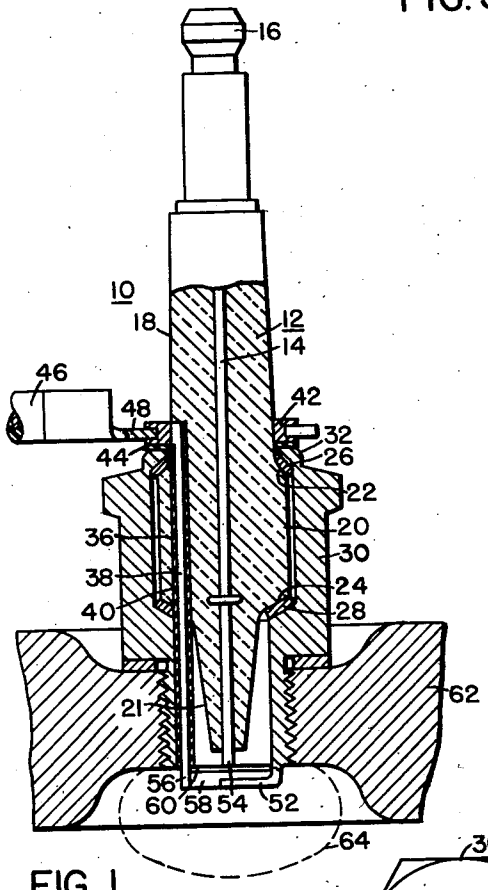


FIG. 1.

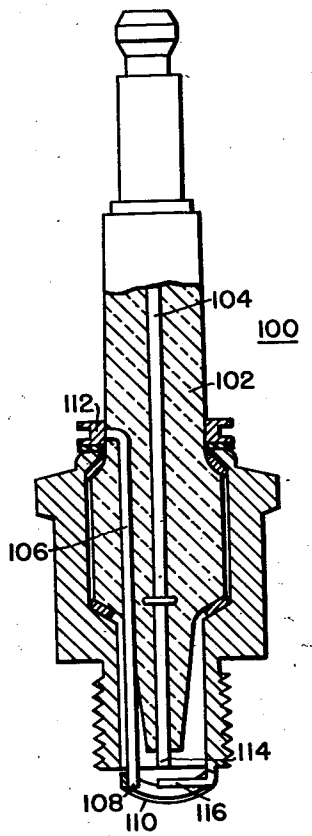


FIG. 4.

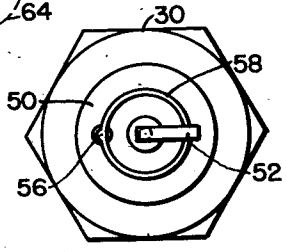


FIG. 2.

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SPARK PLUG

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5 Claims. (Cl. 313—11.5)

This invention relates to spark plugs, particularly adapted for use in internal combustion engines.

While it has been proposed heretofore to apply a heating element adjacent to the porcelain core of a spark plug in order to effect improvements in the operation of such spark plugs, such proposals have only resulted in limited benefits. In particular, the heating of the porcelain by the closely disposed heating element produces but little improvement in the operation of an internal combustion engine. Much of the heat produced by the element is absorbed by the porcelain, and while this may improve the electrical insulation resistance of the porcelain, it has little effect on the ignition of the combustible gases by the spark plug.

At the present time, the carburetors of internal combustion engines are so constructed that under starting conditions an abnormally large quantity of fuel is fed into the combustion chamber. This is designated as choking, and often results in flooding of the combustion chamber. Ignition is difficult, if not impossible, when the combustion chamber is flooded with fuel. At abnormally low temperatures, water may be present in the combustion chamber. The vaporization of the fuel is progressively poorer at lower temperatures and combustion is thereby less liable to occur. The presence of excess fuel and water also render starting an increasingly difficult problem as the temperature drops. Both automatic chokes and hand choking fail to take into account these various circumstances adverse to proper engine starting, so that their action makes starting more of a problem at low temperatures such as are met in winter.

The object of my invention is to provide a spark plug with a heating means disposed around the spark gap, but spaced away from the spark plug proper and into the combustible gas, whereby a substantial spherical zone of the combustible gas mixture adjacent to the igniting spark gap is heated and thereby rendered more perfectly and rapidly combustible than would otherwise be possible, particularly under adverse conditions.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

For a better understanding of the nature and objects of the invention, reference should be had to the following detailed description and drawings, in which all the figures have been greatly enlarged:

Figure 1 is a view in elevation partly in cross section of a spark plug in accordance with my invention,

Fig. 2 is a bottom plan view,

Fig. 3 is a top plan view, and

Fig. 4 is a view in elevation partly in section of a modified spark plug construction.

In accordance with my invention, a spark plug is provided with a heating element surrounding the spark gap which is adapted to be energized with low-voltage high-amperage current from a suitable battery or other source of electrical energy, the heating element being located beyond the usual body of the spark plug and into the combustion chamber so as to heat a substantial volume

of combustible gas adjacent to and surrounding the ignition spark gap of the spark plug. By this means substantially all of the heat developed in the heating element is applied to the combustible gas immediately about the spark gap so that only a relatively negligible proportion of the heat is absorbed by any portion of the spark plug proper. Any unvaporized gasoline is converted to gaseous vapor.

Referring to Fig. 1 of the drawing, there is illustrated one modification of a spark plug **10** constructed in accordance with my invention. The spark plug **10** comprises an insulating porcelain body **12** carrying along its axis an electrode **14** which is connected to the contact **16** receiving electrical current from a suitable wire from a distributor or other source of electrical voltage current, as is well known. The porcelain body **12** comprises an upper portion **18**, an enlarged central portion **20**, and a lower tapered portion **21**. The enlarged central portion **20** is provided with an upper shoulder **22** and a lower shoulder **24** against which are applied gaskets **26** and **28**, whereby the porcelain is retained in gas tight relationship within a hexagonal metal body **30**. A flange **32** spun over the gasket **26** serves to retain the porcelain rigidly within the hexagonal metal shell **30**.

A longitudinal passageway **36** is formed through one side of the enlarged portion **20**. A metallic conductor **38** provided with suitable sealing insulation **40**, such as a ceramic refractory, projects through the passageway **36**. The upper end of the conductor **38** is affixed to a peripherally slotted contact **42** encircling the portion **18** with an insulating ring **44** of mica, asbestos, or other material being disposed to insulate it from the flange **32**. A lead **46** connected by a manually operated switch (not shown) to a storage battery or other source of low voltage, high-amperage electrical enregy is provided with a spring clip **48** adapted to fit resiliently within the peripheral slot of the contact **42** whereby good electrical contact is maintained. Extending below the metal shell **30** is a threaded cylindrical portion **50** enabling the spark plug to be threadedly inserted into the cylinder head **62** or the like of an internal combustion engine. At the lower end of the cylindrical portion **50** is a bent electrode tip **52** adapted to cooperate with the tip **54** at the bottom of the electrode **14**, to form a spark gap therebetween. The conductor **38** terminates in a projection **56** bearing a heating ring **58** of a suitable resistance metal, such, for example, as platinum or the well known 20–80% chromium-nickel alloy. The side of heating ring **58** opposite to the projection **56** is affixed to the electrode tip **52**. It is evident that a substantial space **60** separates the heating ring **58** from the cylindrical portion **50**. The ring **58** may be a ½ inch diameter ring of 1/16 inch wide strip of a thickness of 0.020 inch.

In operation of an internal combustion engine fitted with the spark plug of this invention, when low voltage, high amperage electrical current passes through the lead **46** to contact **42**, thence to conductor **38** and finally to the heating ring **58**, and then to ground via tip **52** and portion **50**, the ring **58** will become hot and within a few seconds the adjacent body of combustible gas will become heated thereby to a substantial temperature. The isothermal lines of circumambient gas heated by the ring will be of the shape generally indicated by the dotted lines **64**, with the maximum temperatures being substantially adjacent the ignition spark gap between **52** and **54**. Under these conditions, if high-voltage current is passed through the spark gap combustion of a combustible gas mixture within the volume indicated by **62** takes place promptly and efficiently.

I have discovered that a very brief flow of current through the heating ring **58**, for example, for a few seconds, is adequate to cause an internal combustion engine to start promptly and to operate without any difficulty

even in exceptionally cold and difficult conditions. As is well known, small internal combustion engines of the type used for lawn mowers are quite difficult to start in cold weather, and especially after they have been out of use for considerable periods of time. Spark plugs constructed in accordance with my invention, as shown in Fig. 1, have been applied to such small motors, and I have had no difficulty in causing them to start on the first spin of the flywheel and to keep operating thereafter without fail at all times. Usually, I have passed heating current through the lead 46 to the heating ring 58 for a few seconds, turned over these motors once and have had them start and keep running promptly. After the motor has operated for 10 seconds or so, I have opened the switch to the lead 46 to interrupt flow of electrical current to the heating ring 58, and the motors have continued to operate successfully. In other cases, I have left the current flowing to the heating ring 58 throughout the entire period the engine was kept in operation.

My invention is particularly well adapted for use in automobile engines, motor boat engines, and aircraft and fire engines which are subjected to dampness and extremely low temperatures. The heating ring 58 may be energized for a few seconds or so and then the engine turned over, whereupon it will fire properly and run successfully. I have made tests of the spark plug provided with the heating element in internal combustion engines at low temperatures and found them to enable easy and prompt starting where otherwise the motor must be turned over many times. Without the spark plug, the motor will often fire weakly once and then stop and require several starting operations before successful and continuous operation occurs.

Referring to Fig. 4 of the drawing, there is illustrated a modified spark plug 100 having a porcelain body 102 within which is disposed a high voltage electrode 104 through which ignition current passes and a low voltage conductor 106 through which low voltage heating current passes, both of the conductors being molded or affixed within the porcelain simultaneously and fired as is well known. A peripherally slotted contact 112 is soldered or welded or otherwise affixed to the upper end of the conductor 106. The electrode spark tips 114 and 116 function to ignite the combustible mixture. The lower end 108 of the conductor 106 is welded or affixed to a downwardly projecting heating ring 110 spaced from the spark plug body proper. Also, a single loop may extend downwardly from 108 to 116. Otherwise the function and operation of the plug modification of Fig. 4 is similar to that of Fig. 1. It will be appreciated that the heating ring 110 projects further into the combustible mixture than ring 58 of Fig. 1, and thereby is a more efficient heater.

It will be understood that the description and drawings are illustrative and not limiting. Thus, other refractory insulating materials than porcelain may be employed for the body 12 and 102, for example, mica and glass may be employed. The construction and assembly of the spark plug may enable it to be taken apart or otherwise suit requirements. While the heating ring 58 is shown as being circular, it will be appreciated that it can be elliptical, hexagonal or of other shape.

I claim as my invention:

1. A spark plug comprising a refractory insulating body, with a first electrode passing through the body, the upper end of the electrode being provided with a contact to receive a lead wire, a metal shell disposed about refractory insulating body, the metal shell terminating in an open ended, threaded cylindrical portion surrounding both the lower end of the porcelain body and the lower end of the first electrode, a second electrode attached to the cylindrical portion and ending adjacent to the lower end of the first electrode to form therebetween a spark gap, a conductor passing through the refractory body, the conductor having an upper end affixed to a contact adjacent the upper end of the metal shell, the lower end of the conductor affixed to a heating element to conduct electrical current thereto, the heating element being composed of an electrically resistant metal, means at the portion of the element opposite to the part affixed to the conductor connecting it to the lower end of the cylindrical portion, the heating element being disposed below and spaced from the cylindrical portion whereby when electrical current is passed from the conductor to the heating element the element is highly heated and thereby heats adjacent gases, the heating element having approximately the resistance between diametrically opposed points of a ring of ½ inch diameter and of a cross-section of 1/16 inch by 0.020 and of 20%–80% chromium-nickel alloy, whereby the heating element may be operated directly from a storage battery simultaneously while sparking current is supplied to the first electrode without the heating element causing misfiring.

2. The spark plug of claim 1, wherein the means connecting the heating element to the cylindrical portion includes the second electrode.

3. The spark plug of claim 1, wherein the contact at the upper end of the conductor is a peripherally grooved ring encircling the refractory insulating body.

4. The spark plug of claim 1, wherein the heating element is a circular ring.

5. The spark plug of claim 1, wherein the heating element is a downwardly extending loop.

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