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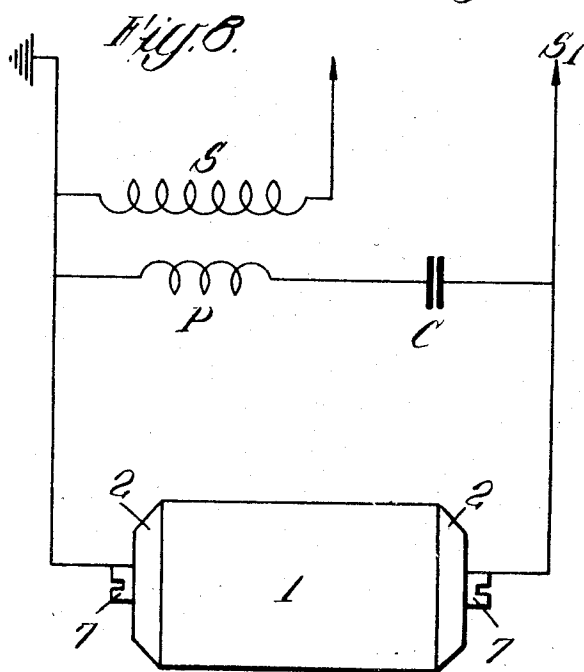
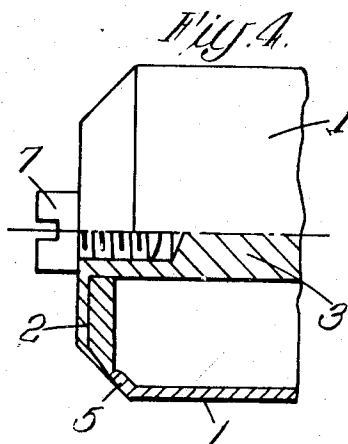
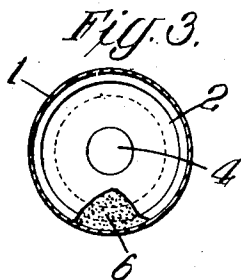
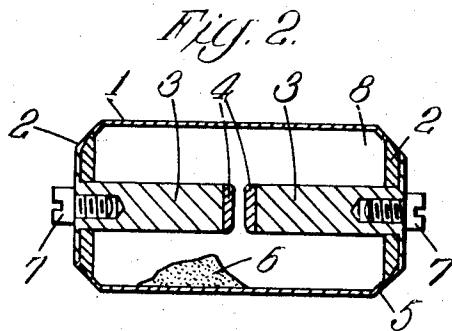
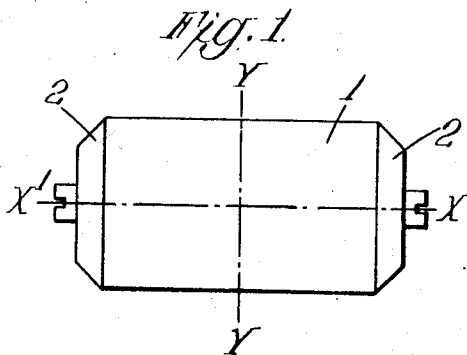
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2,397,764

SPARK GAP FOR USE MORE PARTICULARLY IN HIGH-FREQUENCY
IGNITION SYSTEMS FOR INTERNAL-COMBUSTION ENGINES

Filed June 1, 1942

2 Sheets-Sheet 1



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Fig. 5.

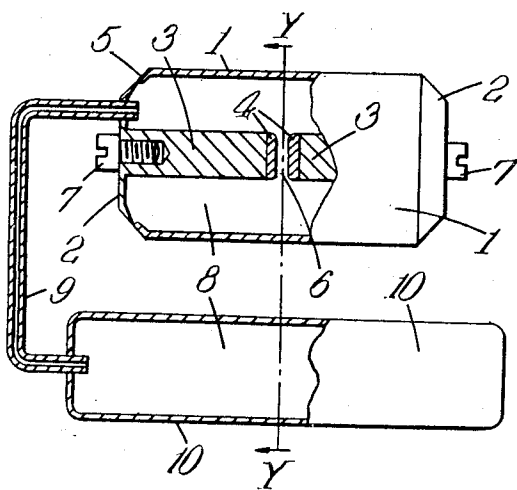


Fig. 6.

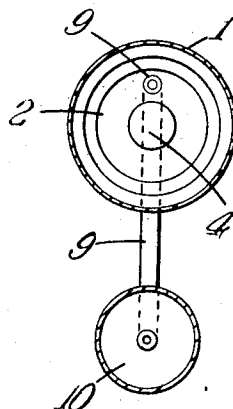
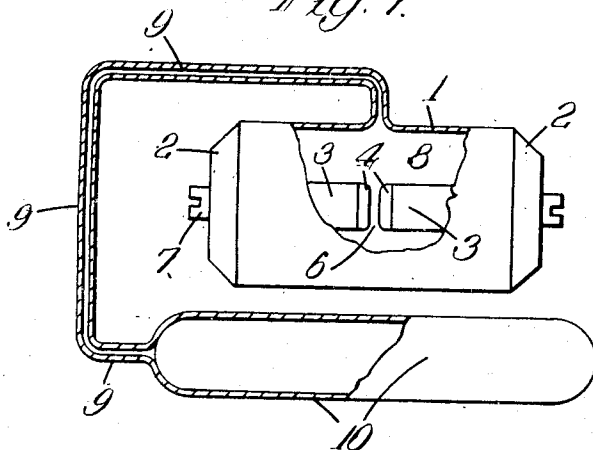


Fig. 7.



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UNITED STATES PATENT OFFICE

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SPARK GAP FOR USE MORE PARTICULARLY IN HIGH-FREQUENCY IGNITION SYSTEMS FOR INTERNAL-COMBUSTION ENGINES

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9 Claims. (Cl. 123—148)

This invention relates to spark gaps of the type adapted with particular advantage for use in high-frequency ignition systems for internal combustion engines; in such systems as is known a condenser is caused to discharge through a spark gap in series with the primary winding of a transformer and difficulties are frequently found to arise from erratic performance of the spark gap.

It has now been discovered that calcium fluoride has a remarkable stabilising effect on the breakdown of such gaps and one characteristic feature of the invention consists in the provision of this material in the gap proper or in one or more of the parts of the device by which the gap is confined. With great advantage the calcium fluoride is used in the form of a loose powder in the gap proper but it may alternatively or in addition if desired be embodied for example in the material of one or both electrodes. Our investigations have shown that in a tube containing calcium fluoride in the gap in powder form sputtered metal from the electrodes is cleaned up mechanically and does not deposit on the glass to any serious extent whereas in a tube which has no such powder in the gap sputtered metal does deposit on the glass and soon causes erratic results. Under these conditions the breakdown voltage (commonly referred to as the starting voltage) fluctuates, discharges take place from the electrodes to the deposit on the glass, and the device becomes useless for the purpose required. The presence of powder in the gap would seem to have the effect that the powder is maintained in a state of violent agitation by the action of the spark and apparently takes up the metal which comes off the electrodes purely physically involving no chemical action. The atmosphere of the gap itself may be air but it is preferred to use a gas such as particularly nitrogen at atmospheric pressure or argon by the presence of which we believe the tendency to sputtering can be further reduced.

The electrodes may conveniently be discs of nickel or nickel alloy mounted on metal supports spaced apart by insulating material, use being made of suitable gas-tight seals. Alternatively the gap may be hermetically sealed in a vitreous or ceramic container. If it is desired to incorporate the calcium fluoride in one or both electrodes use may be made of any of the well-known methods of powder metallurgy. For example, finely divided nickel may be ball-milled with approximately 10% of calcium fluoride for forty-eight hours, and the resulting mixture pressed into a compact at about 20 tons per square inch, 55

the compact being then sintered at a temperature of 950° C.

According now to a further feature of the invention the gap proper is connected through a capillary tube to a reservoir containing a gas such as nitrogen, the capillary tube connecting to a suitable aperture or passage in the body of the spark gap. This arrangement may be used whether or not calcium fluoride is employed; when calcium fluoride is employed it is not placed in the reservoir although some may diffuse therein by way of the capillary tube during operation.

The invention will now be more fully described by reference to the examples illustrated in the accompanying drawings in which the same reference numerals have been adopted to indicate the same or analogous parts.

Fig. 1 is an elevational view and Fig. 2 a longitudinal axial section on the line X—X of Fig. 1 of one constructional form of the spark gap device;

Fig. 3 is a cross section on the line Y—Y of Fig. 1; and

Fig. 4 illustrates in partial section on an enlarged scale one end portion of the view shown in Fig. 2;

Fig. 5 represents the combination of a spark gap as above referred to with a gas supply arrangement according to this invention;

Fig. 6 is a transverse section of the arrangement taken on the line Y—Y of Fig. 5 the gas reservoir shown in these figures being deemed to be of metal;

Fig. 7 is a similar view to Fig. 1 in which the gas container employed is deemed to be of glass, and

Fig. 8 illustrates diagrammatically the arrangement of the device in a circuit for use in a high frequency ignition system.

As represented in the Figs. 1 to 4 the device comprises a glass tube 1 of cylindrical cross section which is closed at each end by a cap 2 which caps are constructed to carry the supports for the electrodes proper 3 and consist preferably of copper. The electrodes 3 are copper rods the inner ends of which are adapted to carry the electrode material 4 here shown in the form of discs which may be of nickel or nickel alloy. The caps 2 are connected to the ends of the tube 1 by copper glass seals 5 as indicated more particularly in Fig. 4. The reference 6 indicates the charge of calcium fluoride powder, 7 are the connecting terminals and 8 is the interior containing air or a gas such as nitrogen or argon at atmospheric pressure. The calcium fluoride powder

used with advantage is of a fineness which will pass easily through a 200 mesh sieve when it will be found fine enough to be blown into the sparking space during the operation of the gap. The sealing of the copper electrode supports 2 to the glass tube 1 may be effected by any well known method.

As regards the calcium fluoride it is recommended to use .2 gram of approximately 200 mesh powder in one spark tube of a capacity of about 5 cc.

As already pointed out the calcium fluoride is with advantage used in the gap in the form of a fine powder with the apparent effects already referred to, particles of nickel being readily detectable in the calcium fluoride under the microscope in spark tubes provided with nickel electrodes. It is obvious, however, that this material may if desired be embodied instead in one or more of the metal constituents of the device such as preferably one or both electrodes by which the spark gap proper is confined, or as likewise already pointed out calcium fluoride may be used both in powder form in the gap proper and in one or both of the electrodes or other parts of the device and the atmosphere of the gap itself may be air or a gas such as preferably nitrogen or argon.

Now as shown in Figs. 5, 6 and 7 the spark gap again consists of a glass tube 1 closed at both ends by caps 2 which are constructed to carry the electrode supports 3 and preferably consist of copper. The electrode supports 3 which preferably are integral with the caps 2 are copper rods supporting the electrode material 4 again preferably in the form of discs of nickel or nickel alloy. The connection between the tube 1 and the caps 2 is effected in any known manner but preferably by copper-glass seals. The sparking gap proper between the electrodes and the interior space 8 of the tube are according to this invention charged with an atmosphere of gas such as preferably nitrogen or argon the supply of which is maintained by the association of the spark gap tube with a gas reservoir as shown at 10 which may be of metal or as shown in Fig. 7 of glass. To this end according to Figs. 5 and 6 the metal reservoir 10 is connected with one of the caps 2 by means of a capillary tube 9 of metal which is soldered at one end into one of the caps 2 and at the other end into the reservoir. In Fig. 7 the capillary tube 9 consisting of glass is shown to be made in one both with the tubular body of this spark gap and with the gas reservoir itself. 7 are again the terminals of the device by means of which it is connected in the circuit of a high frequency circuit in any well known manner.

As already pointed out this arrangement has been devised to provide and maintain the requisite gas supply for the gap with the advantages hereinafter mentioned but if desired the gap may in addition contain calcium fluoride either in the form of a powder or embodied in one or both electrodes or other metallic parts of the device.

The gas reservoir will be found to have the following usual effects:

(a) it permits the use of a larger volume of gas for a given size of spark gap,

(b) it reduces the effects of adsorption of gas in the spark gap and eliminates the necessity of de-gassing the electrode material, and

(c) it minimises the effects of physical and chemical changes, e. g. temperature rise and dissociation, which occur in the spark gap.

Fig. 8 represents by way of example one of the usual circuits showing the arrangement of the spark gap 1 therein in which SI indicates a source of EMF which may be an alternator or magneto, C the condenser P, the primary of a high frequency transformer the secondary S of which is connected in the usual manner to the distributor D of the high frequency ignition system. The spark gap is caused to flash when the potential whether direct current or alternating is of a predetermined value above earth dependent upon the distance between the spark electrodes. When this occurs as is well known high frequency oscillations are produced determined by the values of the capacity of the condenser C and the inductance in series therewith. These high frequency oscillations are induced into the secondary S from primary P and from there to the distributor D.

It will be obvious to those skilled in the art that the invention would not be held to be limited to its use with either a spark gap construction or to a gas supply arrangement as hereinbefore particularly described but should be deemed to include spark gaps of any construction which can be readily adapted for the useful embodiment therein of calcium fluoride in any of the forms referred to or for its association with a gas supply of the type illustrated herein.

I claim:

1. A spark gap of the type described comprising a casing of insulating material and in the interior thereof in association with the electrodes a charge of calcium fluoride in the form of powder of a fineness adapted to be blown into the sparking space during the operation of the device substantially as and for the purpose set forth.

2. A spark gap of the type described comprising a casing of insulating material and in the interior thereof in association with the electrodes calcium fluoride embodied in one of the metallic parts of the spark gap within said casing substantially as set forth.

3. A spark gap of the type described comprising a casing of insulating material, end closures for said casing in the form of metal caps, electrode supports extending from said caps co-axially to the interior of the gap, electrodes carried by said supports and calcium fluoride embodied in said electrodes by incorporation therein by a powder metallurgical method substantially as set forth.

4. A spark gap of the type described comprising an external casing of glass, copper caps hermetically sealed to the ends of said casing, copper electrode supports extending co-axially to the interior of said casing, nickel electrodes carried by said supports and forming between them a sparking space and a charge of calcium fluoride powder within the gap proper of a fineness adapted to be blown into said sparking space during the operation of the gap substantially as set forth.

5. A spark gap of the type described comprising an external casing of insulating material, electrodes hermetically enclosed in said casing and a gas such as nitrogen without oxygen contained in said casing under atmospheric pressure substantially as and for the purpose set forth.

6. A spark gap of the type described comprising an external casing of insulating material, electrodes hermetically enclosed in said casing, a gas reservoir externally of said casing and means for establishing capillary communication between said reservoir and said casing substantially as set forth.

7. A spark gap of the type described comprising

an external casing of insulating material, metal caps hermetically sealed to the ends of said casing, electrode supports of copper extending coaxially to the interior of said casing, nickel electrodes carried by said supports, a reservoir for supplying gas such as nitrogen to the spark gap and a tube connecting said casing and said gas reservoir to establish capillary communication between them.

8. A spark gap of the type described comprising an external casing of insulating material, electrodes hermetically enclosed within said casing, a gas such as nitrogen in the interior of said

casing and a charge of calcium fluoride in the interior of said casing in the form of powder of a fineness adapted to be blown into the sparking space during the operation of the spark gap.

9. A spark gap of the type described comprising an external casing of insulating material, electrodes hermetically enclosed within said casing, a gas such as nitrogen within said casing and calcium fluoride embodied in metallic parts within the interior of said casing by incorporation therein, substantially as set forth.

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