April 20, 1948. H. E. OLES 2,440,153

METHOD OF MAKING SPARK GAPS AND PRODUCTS THEREOF

Filed July 4, 1945

Fig. 2

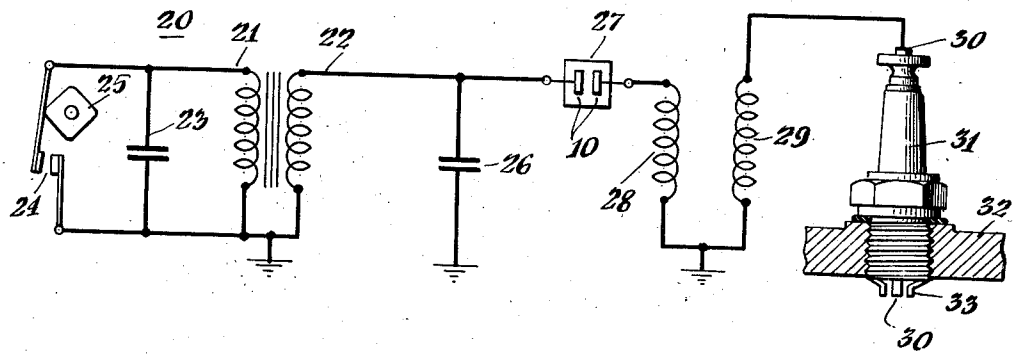


Fig. 1

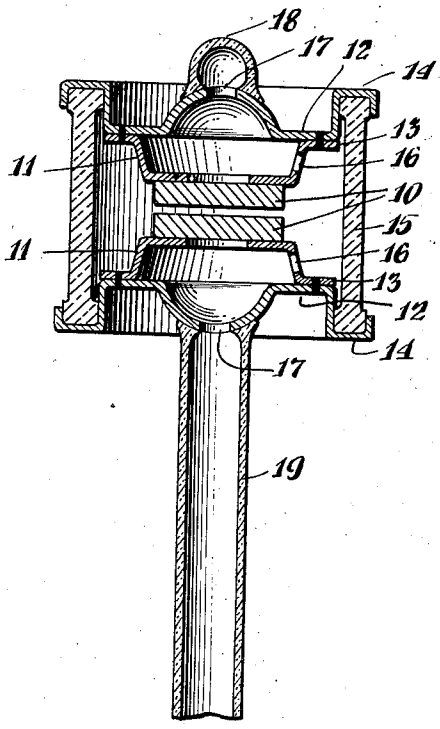
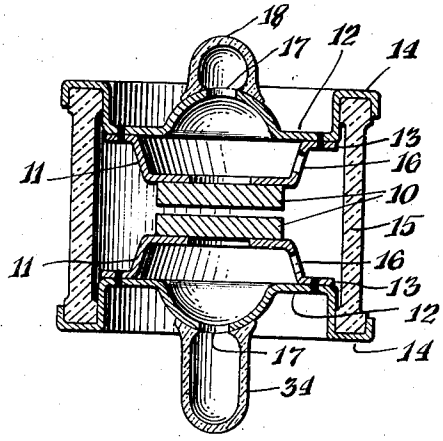


Fig. 3



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Patented Apr. 20, 1948

2,440,153

UNITED STATES PATENT OFFICE

2,440,153

METHOD OF MAKING SPARK GAPS AND PRODUCTS THEREOF

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Application July 4, 1945, Serial No. 603,203

5 Claims. (Cl. 315—85)

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The present invention relates to spark gaps or impulse gaps and to a novel method of making such gaps.

Spark gaps or impulse gaps are used at present for various applications, of which the principal one is their use in high frequency ignition systems. In general, such gaps comprise two spaced electrodes which are connected in an electric circuit capable of building up a high voltage between the electrodes so as to produce a spark discharge between the same. The spark discharge may be used to produce high frequency oscillations in a work circuit and for other purposes. Spark gaps of the described character are disclosed, for example, in Patent Number 2,354,786 granted to Alexander C. Wall on August 1, 1944, and also in a co-pending application of Alexander C. Wall and Herbert E. Oles, Serial No. 582,136, filed on March 10, 1945.

It is an object of the present invention to improve the characteristics of spark gaps or impulse gaps of the described type.

It is another object of the invention to provide a method of producing spark gaps having extremely stable characteristics and particularly having a very stable break-down voltage.

Other and further objects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawing; in which

Figure 1 is a longitudinal sectional view of a spark gap embodying the invention during the process of its manufacture;

Figure 2 is a circuit diagram of a typical impulse circuit employed in carrying the principles of the invention into practice; and

Figure 3 is a sectional view of the finished spark gap embodying the invention.

Referring now to Figure 1 of the drawing, reference numeral 10 denotes a gap electrode of a generally circular shape constituted of a suitable refractory metal, such as, for example, tungsten. This electrode is brazed or otherwise mounted on a cup-shaped electrode holder plate 11. An end plate 12 is welded to flange 13 of holder plate 11 and is provided with a U-shaped annular channel 14.

Electrode 10, holder plate 11 and end plate 12 constitute an electrode assembly. This assembly is mounted together with another assembly of identical character so that the two electrodes of the respective assemblies are held in parallel-spaced cooperating position. This is accomplished by means of a spacer tube 15 of glass or some other material of an insulating character,

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the ends of which are inserted into the annular channel 14 of the end plates. Preferably, end plates 12 are constituted of a suitable iron-chromium alloy which may be directly sealed to glass thereby providing a stable and hermetically sealed construction. The inner space surrounding the electrodes and defined by end plates 12 and spacer tube 15 is initially in communication with the external atmosphere through openings or ports 16 provided in the electrode holder plates 11 and through openings 17 in the center portion of the end plates 12. One of the openings 17 may be sealed by means of a glass bead 18 while the corresponding opening 17 of the other end plate has a glass tube 19 sealed thereto and provides a channel or duct through which the inner space of the gap may communicate with the external atmosphere. As spark gaps of the described character and the method of making the same are fully disclosed in the said co-pending application Serial No. 582,136, no detailed description of the construction of the gap will be necessary.

I have discovered that the operating characteristics of a gap of the described character may be greatly improved by means of a special conditioning treatment after the structural completion of the gap and prior to applying the final seal thereto. This treatment comprises connecting the gap in a typical impulse circuit which periodically applies high voltages to the electrodes of the gap. The impulse generating circuit may comprise a suitable source of electromotive force, such as a conventional ignition magneto. The wave form generated may be such that it has approximately a 1000 cycle rate of rise and the output may be approximately 2000 volts peak when connected across a .015 microfarad condenser without the gap. The work circuit may comprise a typical lead and spark plug operating in a bomb containing nitrogen, or some other suitable inert gas, with fifty pounds pressure on the nose of the plug. The application of these periodically acting impulses may be carried on for an extended period such as for twenty hours, or more. It has been found that if the gap is filled with a suitable gas after this treatment and sealed, a spark gap of superior operating characteristics and of greatly increased stability is obtained.

The invention will now be more fully described in connection with Figure 2 in which a typical impulse circuit is diagrammatically shown. The circuit comprises a magneto, generally denoted by reference numeral 20. The magneto includes

a primary winding 21 and a secondary winding 22, which are inductively coupled to each other. One end of both windings is grounded and a condenser 23 is connected across primary winding 21. The magneto also includes a pair of interrupter contacts 24 operated by means of a rotary cam 25.

Another condenser 26 of suitable capacity is connected across secondary winding 22 of the magneto. The spark gap to be treated, including electrodes 10 and diagrammatically shown as element 27, is connected between the common terminal of secondary winding 22 and condenser 26, and one end of primary winding 28 of a step-up transformer. The other end of said winding 28 is grounded. Primary winding 28 is inductively coupled with secondary winding 29 of the step-up transformer one end of which is connected to the center terminal 30 of a spark plug 31. This spark plug is inserted into a pressure-resistant container or bomb 32. The bomb may be filled with a suitable gas, such as nitrogen, under a pressure of fifty pounds per square inch, in order to simulate the operating conditions within the cylinders of an internal combustion engine.

In carrying out the method of the invention, the spark gap 27 to be treated is connected into the impulse circuit of Figure 2. In order to obtain the desired results, it is essential that the gaseous products of the presparking treatment be continuously removed from the interior of the spark gap. In the simplest case, this may be accomplished by maintaining the interior of the gap in communication with the atmosphere through ports 16 and 17 and glass tube 19 (Fig. 1). It is also possible, however, to pass a flow of a filtered and cleaned gas, such as air, through the gap, said flow being introduced through tube 19 and withdrawn or discharged through port 17 before it is sealed at 18.

During the operation of the magneto, a high voltage, as described, is periodically built up across condenser 26. After this voltage has reached the break-down voltage of gap 27, an oscillatory discharge will take place through said gap and through primary winding 28 of the step-up transformer. An oscillatory current of similar high frequency but of considerably higher voltage will be built up across secondary winding 29 and will produce high frequency sparks between center electrode 30 and electrodes 33 of spark plug 31.

This presparking treatment is preferably continued for an extended period of time such as for twenty to forty hours. In general, a presparking treatment for approximately twenty hours at about twenty-two sparks per second has been found to provide satisfactory results.

After the presparking treatment has been completed, the spark gap may be evacuated, filled with a suitable gaseous charge, and is hermetically sealed. Excellent results, however, have been obtained by sealing the spark gap immediately after the presparking treatment without a preliminary evacuation process. In that case, the inner space of the gap will be filled with a gaseous charge having a composition which is substantially identical with that of atmospheric air, that is, it will contain approximately 21 per cent of oxygen, 79 per cent of nitrogen and traces of certain noble gases found in small quantities in atmospheric air, such as helium, neon, argon, krypton and xenon. This charge will be under normal atmospheric pressure, corresponding to the pressure at the time of sealing the gap.

The finished gap is illustrated in Figure 3 and is in every respect identical with that shown in Figure 1, except that glass tube 19 has been sealed off close to the lower end plate, constituting a glass bead 34 similar to glass bead 18 sealing the upper end plate.

Experience has demonstrated that a spark gap produced in accordance with the principles of the present invention provides important advantages. Thus, the spark gaps made by the method of the invention possess extremely stable physical characteristics. For example, the voltage necessary to produce a discharge between the electrodes will vary only as little as five per cent or less. Moreover, spark gaps prepared according to the invention will retain their desirable physical characteristics for a very long time and as a result, have a very long useful life.

The physical principles underlying the descried presparking treatment and responsible for the greatly improved operating characteristics of the gaps treated in accordance with the invention are not fully understood. It is believed that during the presparking treatment minute but critically important changes are caused in the electrode surfaces, while the gaseous and solid by-products of the treatment are removed for example by permitting them to escape into the atmosphere. Therefore, any possible initial changes in the physical characteristics of the electrodes and of the gap will already occur during the presparking period which is continued until such characteristics are permanently stabilized. While this explanation appears to be well supported by experimental evidence, the invention is, of course, independent from the merits of any theoretical consideration.

Although the present invention has been disclosed in connection with a preferred embodiment thereof, variations and modifications may be resorted to by those skilled in the art without departing from the principles of the invention. I consider all of these variations and modifications to be within the true spirit and scope of the present invention, as disclosed in the foregoing description, and defined by the appended claims.

What is claimed is:

1. The method of making impulse gaps of stable characteristics which comprises providing a pair of spaced plane electrodes constituted of refractory metal within a gas-tight container, maintaining said container in communication with the external atmosphere, presparking said electrodes for a period of several hours, and then hermetically sealing said container.

2. The method of making impulse gaps of stable characteristics which comprises providing a pair of plane parallel-spaced tungsten electrodes within a vessel adapted to be hermetically sealed, initially maintaining the interior of said vessel in communication with the external atmosphere, connecting said electrodes to an impulse circuit to produce a plurality of electric sparks per second between said electrodes for a period of several hours, and hermetically sealing said vessel after said sparking period thereby to obtain an impulse gap of stable operating characteristics.

3. The method of making impulse gaps of stable characteristics which comprises providing a pair of parallel-spaced circular tungsten electrodes within a vessel adapted to be hermetically sealed, maintaining the gaseous atmosphere within said vessel in communication with the external atmosphere, connecting said electrodes to an elec-

trical impulse circuit to produce electric sparks in the order of about twenty sparks per second for a period in the order of about twenty to forty hours, and hermetically sealing said vessel after said sparking period thereby to obtain an impulse gap of stable operating characteristics.

4. The method of making impulse gaps of the type including a pair of spaced electrodes within a sealed vessel which comprises establishing communication between the interior of said vessel and the external atmosphere, presparking said electrodes for a predetermined period while maintaining such communication, and then hermetically sealing said vessel.

5. An impulse gap of stable characteristics comprising a hermetically sealed vessel, a gaseous atmosphere in said vessel having a composition similar to that of the external atmosphere, and a pair of plane electrodes constituted of refractory metal mounted in said vessel in parallel-spaced position, said electrodes having surfaces of such physical characteristics as is obtained by presparking them for an extended period.

HERBERT E. OLES.

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