

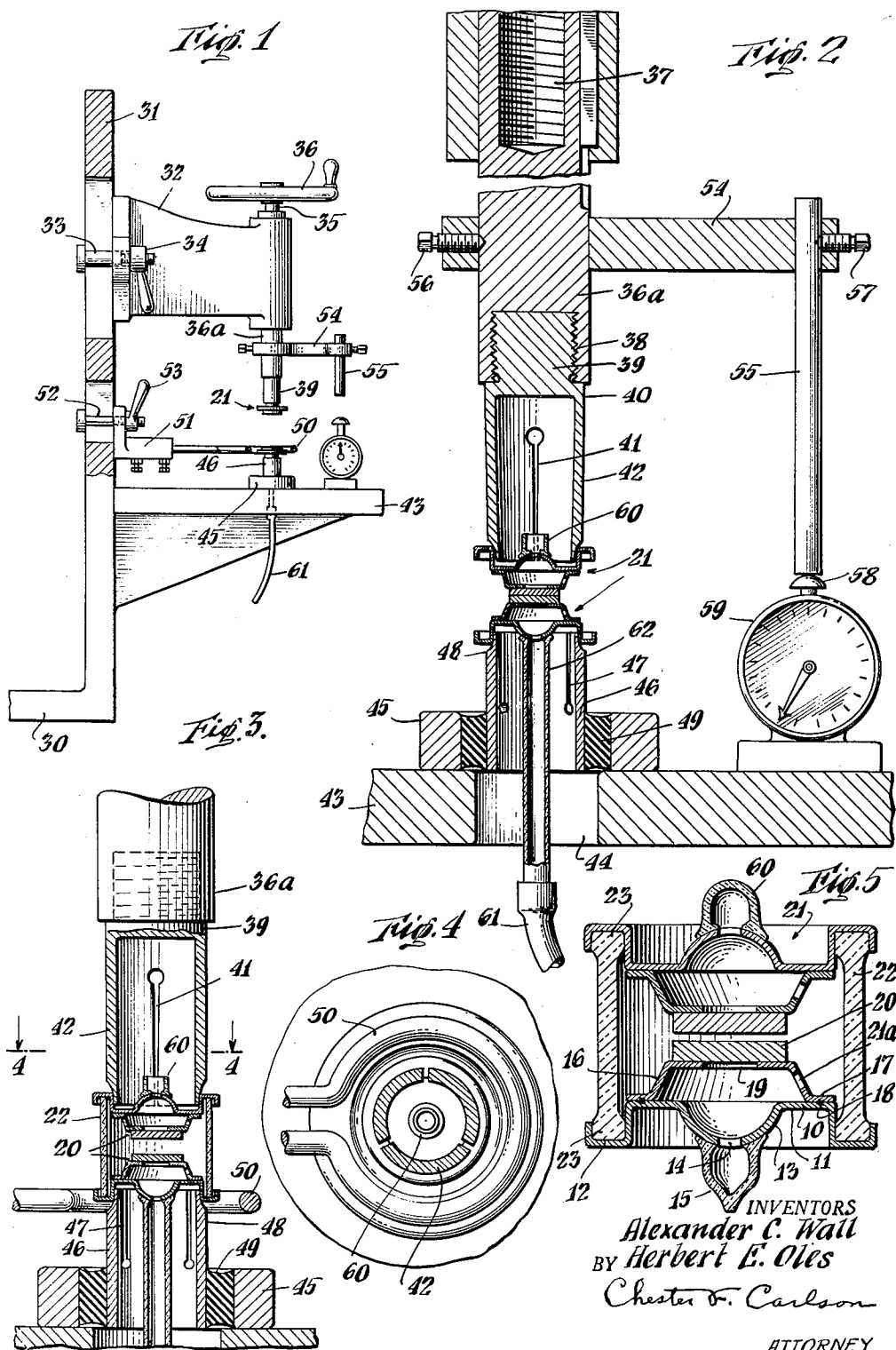
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METHOD OF MAKING SPARK GAPS

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METHOD OF MAKING SPARK GAPS

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The present invention relates to spark gaps of the type used in high frequency ignition systems for converting currents of relatively low frequency into high frequency oscillations and to a novel method of making such spark gaps.

In the co-pending application of A. C. Wall, Serial No. 549,278, filed on August 12, 1944, for Ignition system and apparatus, which issued as Patent No. 2,459,855, there is disclosed a novel ignition system for internal combustion engines including a source of low frequency electrical energy, an oscillating circuit including a spark gap and a condenser to convert the electrical energy to a high frequency current at relatively low voltage, and a transformer to convert the resulting low voltage high frequency energy to a relatively high voltage output for supply to a spark gap comprising a pair of spaced electrodes between which a discharge may take place. A constructional form of such a spark gap is disclosed in U. S. Patent No. 2,354,786, issued to Alexander C. Wall on August 1, 1944.

It is an object of the present invention to provide a method of making spark gaps wherein a pair of contact-bearing end plates are directly fixed and hermetically sealed together by means of an insulative spacer tube.

It is another object of the invention to provide a simple, reliable and satisfactory method of assembling a spark gap from its components whereby the desired exact spacing, concentricity and parallelism of the contact electrodes is positively assured.

The invention also contemplates a method of making spark gaps which is simple in character, and which permits the manufacture of spark gaps on a quantity production scale at a low cost.

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

Fig. 1 is a side elevational view of a machine for making spark gaps and embodying the principles of the present invention;

Fig. 2 is a fragmentary longitudinal sectional view of the gap-making machine, having parts in elevation, and drawn to a slightly larger scale;

Fig. 3 is a similar fragmentary sectional view showing the machine with the spark gap contact holders and the spacer tube fully assembled;

Fig. 4 is a horizontal sectional view taken on line 4—4 of Fig. 3; and

Fig. 5 is a longitudinal sectional view of the finished spark gap, the size of the said spark gap being greatly exaggerated for reasons of clarity.

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The construction of the spark gap embodying the invention will be best understood by referring to Fig. 5. In this figure, reference numeral 10 denotes an end plate formed of sheet metal in a generally circular shape and provided with an inwardly extending annular depression or recess 11. The terminal region of end plate 10 is provided with a generally U-shaped flange 12 opening in a direction opposite to that of recess 11. In the center portion of the end plate there is formed a protuberance or dimple 13 with an aperture 14 in the center thereof. In the finished form of the spark gap, the said aperture is closed by means of a glass bead 15 which is directly sealed to dimple 13 by means of a glass to metal seal.

To the inner face of end plate 10 there is secured a cup-shaped contact holder plate 16 for example by having its flange 17 welded thereto at 18. The flat center surface of contact holder plate 16 is likewise provided with an aperture 19 and has a contact 20 seated thereon and secured thereto by means of welding or brazing. End plate 10 and preferably also contact holder plate 16 are made of a metal which is adapted to be directly sealed to glass. Thus, end plates of chrome iron will readily seal to conventional soft or sodium glass, while plates made of a low-expansion iron-base alloy containing 28–30% nickel, 15–18% cobalt and fractional percentages of manganese are easily sealed to conventional hard glass. Contact 20 may be made of any suitable metal, refractory metals, such as tungsten, being preferred. It will be noted that end plate 10, and contact holder plate 16 define a closed space therebetween, a small aperture 21a being provided in the circumferential portion of the contact holder plate in order to establish communication between said space and the space surrounding contact 20.

End plate 10, contact holder 16 and contact 20 constitute a contact assembly 21, which is spacedly mounted with another contact assembly of identical character, with the contacts 20 concentric, parallel and closely spaced from each other. This spacing is assured by means of a spacer tube 22 of insulating material such as glass, having its ends seated in terminal flanges 12 of the respective end plates and directly sealed thereto, as this is indicated at 23, to provide a hermetically sealed spark gap construction.

It has been found that a spark gap of the described construction provides excellent results and will perform satisfactorily for very long periods of time. It has been also discovered,

however, that the accurate concentricity, parallelism and spacing of contacts 20 is critically important for obtaining these results. The method and machine to be described hereinafter make it possible to obtain this critically important accuracy of construction and spacing on a quantity production scale, without the use of highly skilled labor, and at a low cost.

Referring now more particularly to Figs. 1 to 4 of the drawing, the machine of the invention comprises a frame 30 which may be mounted on a suitable support or may be directly bolted or clamped to a work bench. A pair of machine ways 31 are secured to frame 30 and extend in the vertical direction. In these ways there is slidably arranged a sliding head 32 which may be displaced in the vertical direction and may be clamped in any one of its adjusted positions by means of a locking screw 33 and wrench 34. Sliding head 32 carries a lead screw 35 capable of rotation by means of a hand wheel 36, thus providing for a small controlled movement of member 36a having a threaded portion 37 cooperating with the lead screw. Member 36a is provided with an internally threaded socket 38 adapted to receive and to hold a correspondingly threaded extension of an upper chuck 39. Chuck 39 comprises a downwardly extending cylindrical sleeve 40 with longitudinal slots 41 therein defining three jaws 42 which are externally urged by their resilient character and are adapted to engage annular depression 11 of contact end plate 10.

Support 30 also carries a base plate 43 arranged in horizontal direction and having an aperture 44 therein. This base plate is made of a ferromagnetic material, such as iron or steel. Upon the apertured portion of the base plate rests a permanent magnet 45 of an annular shape which is securely held by the magnetic attraction between the said magnet and the base plate. Within magnet 45 there is mounted a lower chuck 46 having a construction closely similar to that of upper chuck 39 and having a plurality of longitudinal slots 47 defining a plurality of gripping members or jaws 48 therein. Lower chuck 46 is secured to magnet 45 by means of an interposed body or mass 49 of a suitable filler material, such as a low melting point alloy composed of 50% bismuth, 27% lead, 13% tin and 10% cadmium. It will be noted that the lower chuck may be adjusted in the horizontal position by simply sliding it in any direction and will be fixed in any one of such positions by magnet 45.

The machine also includes high frequency heating means for applying heat to any desired portion of the spark gap assembly. These heating means are shown in the drawing in the form of a conductor loop 50 which may surround a portion of the spark gap assembly and is insulatedly supported in a sliding head 51. Head 51 may be vertically displaced in ways 31 and may be fixed in its adjusted position by lock bolt 52 and wrench 53.

It has been found desirable to provide indicator means to indicate the relative position of the upper chuck with respect to the lower chuck or the relative spacing of the contact assemblies carried by such chucks. A convenient form of such indicator means is shown in the drawing and comprises a horizontal arm 54 clamped to the upper chuck holding member 36a and carrying a downwardly extending indicator rod 55. It will be noted that the position of arm 54 on element 36a and the effective length of rod 55 may be adjusted and fixed by means of set screws 56 and 57,

respectively. The lower end of indicator rod 55 is adapted to engage actuating button 58 of dial indicator 59, which is likewise supported on base plate 43. In view of the fact that this dial indicator is of conventional construction and is well-known to those skilled in the art, no detailed description thereof will be necessary.

From the foregoing description the operation of the apparatus and the method of the invention will be readily understood. Referring to Figs. 1 to 3, an upper contact assembly 21 comprising an end plate 10, a contact holding member 16, a contact 20 and a short-length of glass tube 60 sealed to the end plate, is placed in the upper chuck by slightly compressing the upper chuck jaws and releasing them when the contact assembly is in place. The gripping surfaces of the jaws will engage the side walls of depression 11 in the end plate and will securely hold the assembly. This operation places the upper contact face in a roughly horizontal direction, and is carried out when sliding head 32 is at the limit of its upward travel. The lower contact assembly 21 of identical construction is similarly placed in the lower chuck and gas tube 61 is placed over the end of the glass tube 62 of the lower contact assembly. It will be noted that tube 62 is directly sealed to the end plate of the lower assembly and is considerably longer than the corresponding glass tube 60 so that it extends through opening 44 in base plate 43. Sliding head locking wrench 34 is now released and 32 dropped until the contacts are approximately three-fourths of an inch apart. This distance is not critical and in general will be determined by the dimensions of the spark gap to be made. The sliding head is then locked to the base.

By rotating the lead screw hand wheel 36, the contacts 20 are now brought to a short distance, such as $\frac{1}{16}$ of an inch, from one another. This is desirable in order to facilitate observation of the relative position of the two contacts and their alignment into approximately concentric position. The lower chuck 46 is now slid around on the lower base 43 made of magnetic metal, until the two contacts are approximately concentric. The magnetic attraction between permanent magnet 45 and base plate 43 will positively maintain this horizontal adjustment of the lower chuck. The upper chuck 40 is now compressed, which permits the upper contact to fall and rest on the lower contact in such a position that the two contact faces are in surface engagement and obviously parallel. At this time the upper chuck is released and this once more rigidly attaches the upper contact to the machine, with the upper contact face exactly parallel to the lower contact face (Fig. 2). During this operation it may be necessary to lower the upper chuck by means of the rotating lead screw 35 after the contact has been released until it is in such a position that the chuck jaws will again engage with recess 11 provided for them in the contact assembly. The upper contact is now raised a short distance, such as approximately .015 inch and, if necessary, the lower chuck, which carries the lower contact assembly, is adjusted so that once more the contacts are concentric. This may be desirable to correct any accidental changes in the alignment of the contacts that may have been caused as a result of the upper contact assembly being released from and being reengaged by the chuck jaws.

By means of the rotating lead screw, the upper contact is now moved in the upward direction

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for a distance sufficient for insertion of the glass spacer tube 22 between the upper and lower contact assemblies, such as approximately one inch. Glass spacer tube 22 is placed in recess 12 provided for it on the lower contact assembly. The upper contact assembly is now brought down until its recess 12 just touches the upper edge of spacer tube 22 (Fig. 3). A valve (not shown) is now opened to permit a flow of hydrogen through the gas tube 61. The gas passing through glass tube 62 obviously will fill the space between the two contacts and will escape around the upper end of the glass spacer tube and through the gas escape holes 21a provided in the upper contact assembly and contact tube 60.

The induction heater coil 50 is now displaced by loosening wrench 53 until the coil is positioned slightly below the lower contact and the high frequency heater is turned on. The lower contact assembly is brought up to glass sealing temperature at which point the upper contact assembly is moved downward by means of the rotating lead screw, pushing the glass spacer tube into recess 12 of the lower contact end plate and producing a glass seal of the spacer tube to said plate at 23. It will be noted that the hydrogen will now be burning.

Upon completion of the lower seal, induction heater coil 50 is moved upward to a position slightly above the upper contact and is fixed in such position. The upper contact assembly including its end plate, will soon rise to glass sealing temperature. When such temperature has been obtained, the upper contact assembly is moved in the downward direction by means of the rotating lead screw and is caused to seal to the glass. With the heat still on, the upper contact is brought down farther until it is in face to face surface engagement with the lower contact. At this time the upper contact should be in surface engagement parallel, and concentric with the lower contact.

At this point in the operation, the reading on the dial indicator 59 is noted. The induction heater is now turned off and, by means of the rotating lead screw, the upper contact is moved in the upward direction to the predetermined spacing and is stopped when the desired spacing is read on the dial indicator. The upper chuck is now held manually in that position until the glass and metal in the upper chuck have cooled below the flow point of the glass. The upper chuck is now released by compressing the chuck fingers and the chuck is withdrawn from the spark gap in the upward direction by means of the rotating lead screw.

The sliding head lock 34 is now released and the sliding head moved upward to the limit of its travel. At this point in the operation, we have an upper and a lower contact assembly sealed together by means of the glass spacer tube. The contact faces are spaced to the predetermined distance. They are exactly parallel and concentric and are permanently fixed in such a position as a result of the preceding operations. A stream of hydrogen is also passing through glass tube 62 and is burning at the upper end of the glass tube 60, which is sealed to the upper contact end plate.

An auxiliary torch (not shown) is now played on upper glass tube 60 and at the time the glass is about to close on itself, the gas valve is turned off. Continued heating on the said glass tube produces a seal at that point. The lower chuck is released and the spark gap structure removed

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from the chuck. It is now ready for the final processing which may include a suitable pre-sparking treatment, filling the inner space of the spark gap with a substantially inert gaseous atmosphere, etc. Finally, glass tube 62 is cut off close to the lower end plate and its remaining portion sealed resulting in glass bead 15 of the finished spark gap structure illustrated in Fig. 5.

While the present invention, as to its objects and advantages, 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. All of these variations and modifications are considered 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 spark gaps including a pair of metal end plates bearing plane disc-shaped contacts and a spacer tube of fusible dielectric material which comprises fusing the ends of said tube to said end plates while said contacts are in parallel and concentric contacting position, and separating said contacts from each other by a predetermined distance while maintaining their parallelism and concentricity during the time when at least one of the fused ends of the tube is still plastic thereby providing a spark gap having positively uniform spacing throughout the surface of said plane contacts.

2. The method of making spark gaps including a pair of metal end plates bearing plane disc-shaped contacts and a spacer tube of fusible dielectric material which comprises fusing the ends of said tube to said end plates with the contacts in surface engagement and in parallel and concentric relation, pulling said end plates away from each other while at least one of the fused ends of said tube is still plastic to obtain a predetermined contact spacing, and maintaining the exact parallelism and concentricity of the contacts during the said pulling operation thereby providing a spark gap having positively uniform spacing throughout the surface of said plane contacts.

3. The method of making spark gaps including a pair of metal end plates bearing plane disc-shaped contacts and a glass spacer tube which comprises bringing the end plates with the contacts thereon into parallel and concentric contacting relation, separating said contact-bearing plates from each other, interposing the spacer tube between said end plates, applying heat and pressure to said plates and to the regions of said tube in contact therewith to form a glass to metal seal and to return the contacts into their aligned and contacting relation, pulling the end plates away from each other in the axial direction during the time the sealed region at least at one end of the glass tube is still plastic to space the contacts at a predetermined distance while maintaining their parallelism and concentricity, and permitting the tube to cool and to consolidate to permanently fix the contacts in their adjusted position thereby providing a spark gap having positively uniform spacing throughout the surface of said plane contacts.

4. The method of making spark gaps including a pair of metal end plates bearing plane disc-shaped contacts and a glass tube spacing said plates and contacts which comprises bringing the end plates into superposed coaxial relation in which their contacts are directly resting on each

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other and are parallel and concentric, causing relative axial displacement of said plates and contacts, interposing a spacer tube between said end plates to constitute a gap structure, applying heat and pressure to said end plates and to the regions of said tube in contact therewith to form a glass to metal seal and to return the contacts into their aligned and mutually contacting relation, pulling the end plates away from each other in the axial direction during the time the sealed region at least at one end of the glass tube is still plastic to space the contacts at a pre-determined distance from each other while maintaining their parallelism and concentricity, and permitting the tube to cool and to consolidate to permanently fix the contacts in their adjusted position thereby providing a spark gap having positively uniform spacing throughout the surface of said plane contacts.

5. The method of making spark gaps including upper and lower metal end plates bearing plane disc-shaped contacts and a glass tube spacing said plates and contacts which comprises mounting the lower end plate in the horizontal direction, gripping the upper end plate to have its contact approximately parallel-spaced with that of the lower plate, dropping the upper plate to have its contact rest in surface engagement with the lower contact, displacing the lower plate to bring the contacts into coaxial and accurately aligned position, regripping the upper plate, displacing the upper plate from the lower plate and inserting a spacer tube therebetween to constitute a gap structure, applying heat and pressure to said end plates and to the regions of said tube

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in contact therewith to form a glass to metal seal and to return the contacts into their aligned and mutually contacting relation, pulling the end plates away from each other in the axial direction during the time the sealed region at least at one end of the glass tube is still plastic to space the contacts at a pre-determined distance from each other while maintaining their parallelism and concentricity, permitting the tube to cool and to consolidate to permanently fix the contacts in their adjusted position, and releasing the gap structure from the gripped position thereby providing a spark gap having positively uniform spacing throughout the surface of said plane contacts.

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