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SWITCH

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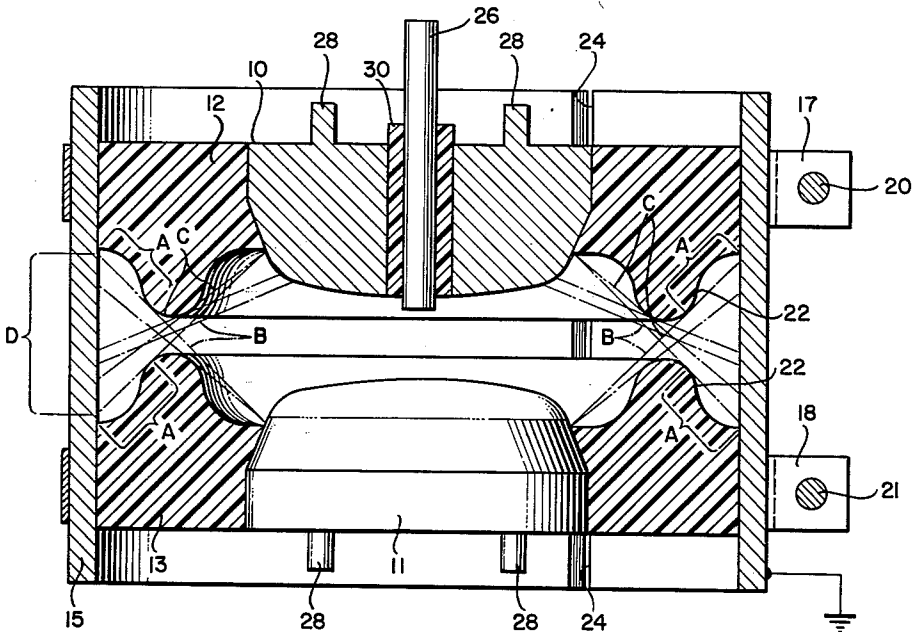
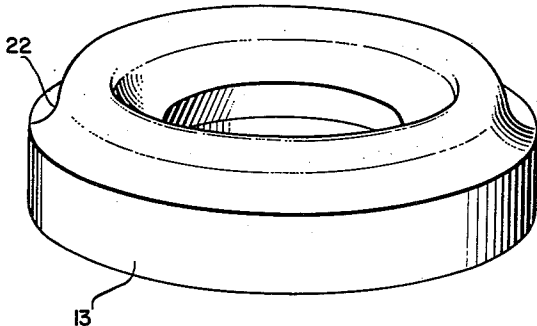


FIG. 1.

FIG. 2.



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1

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SWITCH

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This invention relates to a switch and, more particularly, to a coaxial spark gap switch.

Spark gap switches used in high current discharge work, particularly in high current applications such as plasma physics, are most useful if they meet the requirements of low inductance, long life, reliability, easy maintenance, and simple adjustment. Prior art gap switches are not arranged to incorporate all of these requirements and, therefore, have not proved completely satisfactory. For instance, one of the presently available spark gap switches supports copper electrodes in a spaced relationship by means of ceramic dielectric rods. Thus, although the reliability of such a device is acceptable, its longevity, adjustability, and inductance leave much to be desired. Because of the accumulation of arc residue on the supports of such a spark gap switch, it is more feasible to replace the spark gap switch than to attempt to clean it. Moreover, it is impractical to adjust its gap. With these problems in mind, the need for a longevous and easily maintainable spark gap switch is apparent.

Therefore, an object of the present invention is to provide a spark gap switch having long life, low inductance, and which is easily adjusted and maintained.

According to one embodiment of the present invention, copper or other high melting point (tungsten, molybdenum, tantalum) electrodes are supported in annular insulating members of a material, such as polyethylene or Teflon, which does not char and does not easily become contaminated in the presence of hot metal vapors. A pair of such contacts are coaxially clamped within a split conductive sleeve, which additionally functions as a close fitting ground return to reduce the inductance affecting the spark gap switch and working circuitry. The configuration of the annular insulating member is such that an annular surface thereof remains in shadow during arcing and, therefore, is not exposed directly to high temperature conductive vapors. Moreover, the clamping arrangement for maintaining the annular insulating members at a precise location within the conductive sleeve is severally demountable so that the spacing between the electrodes may be varied easily and so that one or both of the electrodes may be removed easily for cleaning, plating, or other maintenance.

The subject matter which is regarded as my invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. The invention, however, as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following description taken in connection with the accompanying drawing, in which:

FIG. 1 is a sectional plan view of a spark gap switch arranged according to my invention; and

FIG. 2 is a perspective view of a portion of the spark gap switch of FIG. 1.

Referring now to the drawing, there is shown a pair of high melting temperature electrodes 10 and 11 of copper or the like, similarly supported in a pair of annular insulating members 12 and 13, one of which is shown in perspective in FIG. 2. The spacing between the electrodes 10 and 11 may be adjusted to a predetermined distance by sliding the insulating members 12 and 13, relative to each other, within a split copper sleeve 15 prior to the application of the circumferential collar grip

2

clamps 17 and 18 and the associated tension bolts 20 and 21. A slightly cylindrical taper on the electrodes and the matching taper on the insulators facilitate maintaining a constant relative placement.

It is preferred that the annular support insulating members be made of an insulating material of a high dielectric strength which is somewhat resilient, extremely slippery, and which will not char because of arcing. The slipperiness of the surface of the annular insulating members 12 and 13 will enhance the maintaining of an uncontaminated surface thereof. Often, Teflon (polytetrafluoroethylene) is considered to be uncontaminable in most environments. However, in the arc gap switch environment of the present invention wherein high current arc currents cause appreciable vaporization of the metal surfaces of the electrodes 10 and 11, it has been found that surfaces upon which these vapors impinge directly and at high velocities will become contaminated even when such materials as Teflon are used.

Therefore, it is a feature of the present invention to arrange the annular insulating members 12 and 13 each with an axially projecting annular detent 22 so that it is extremely improbable for vapor to impinge directly upon the outer peripheral surface thereof. This peripheral surface or shadow region A remains uncontaminated despite substantial vaporization in the region of the electrodes 10 and 11. The previously mentioned tapered fit between the electrodes 10 and 11 and the insulating members 12 and 13 assures a predeterminable constant area remaining in the shadow of any arc vapors. As illustrated in the drawing, vaporized material B (in dashed lines), generated in the region of the electrodes 10 and 11, may be driven from the region of the electrodes along paths intermediate to those illustrated by the boundary lines C to impinge upon an arcuate surface D of the sleeve 15. In FIG. 1 it is apparent that the surfaces of the detent 22 of the annular insulating members 12 and 13, within the shadow region A, are beyond the defines of the boundary lines C. Thus, although the arcuate surface D may become contaminated by direct impingement thereon of metal vapors, it is physically impossible for metal vapors, generated by high current arcing within the space between the electrodes 10 and 11, to follow a straight path which will cause them to engage the outer shadow regions A at a high velocity. Although the shadow regions A may be exposed to some secondary or deflected radiation from the arcuate surface D, such radiation is nominal and has proved not to contaminate the shadow regions. Therefore, despite large arcing currents between the electrodes 10 and 11, the shadow regions A will remain uncontaminated and the insulating properties of the annular insulating members 12 and 13 are maintained for substantially longer periods of time than prior art spark gap switch arrangements.

On the other hand, copper vapors generated in the region of the electrodes 10 and 11, which impinge upon the arcuate surface D of the split sleeve 15, do not materially change the properties of the spark gap switch because they will merely add small amounts of conductive material to an already conductive member. The split copper sleeve 15, substantially completely surrounding the region of the arc between the electrodes 10 and 11, provides a close fitting ground return and thus minimizes the inductance to this part of the circuit. In addition, the symmetrical arrangement insures storage of minimum magnetic energy in this area when the arc passes between the two electrodes. Any tendency for the arc to jump from the high voltage electrode to the copper ground return is minimized. By reducing the radius r_0 of the sleeve 15 to a value approaching the radius r_1 of the electrodes, the inductance, which is proportional to $\ln r_0/r_1$ is minimized.

The present invention is arranged to provide advantages in addition to those explained above. By the use of the removable clamps 17 and 18 it is now feasible to adjust accurately the spacing between the electrodes 10 and 11 either at the time of initial installation or manufacture of the spark gap switch, or at such time as a new adjustment or other maintenance is required. Moreover, by loosening the clamps 17 and 18 and placing a spreader or wedge (not shown) in a coaxial slot 24, the electrode assembly, including the electrodes and their annular insulating members, may be removed from the spark gap switch. The removed electrode or electrodes may be exchanged for ones having different properties. On the other hand, they may be easily polished as deemed necessary to eliminate various surface roughness or may be coated with a conductive material to eliminate any pits or other deformation thereof. The present clamping arrangement also facilitates both electrical and mechanical coupling of grounded portions of various cables associated with the spark gap switch. As a result of this construction and easy maintenance it becomes economically feasible to make the spark gap switches of relatively expensive materials because they may be remachined without addition of large amounts of such expensive materials and may be used for extremely long periods of time.

In one type of spark gap switch there is provided a triggering electrode 26 as well as the main current connections 28. Usually the triggering electrode 26 terminates at or adjacent to the active surface of one of the electrodes and is supported by a small cylindrical insulating sleeve 30.

What is claimed is:

1. A spark gap switch comprising: a pair of electrodes, mountable and spaced from each other in a substantially coaxial alignment; a pair of annular insulating members, each supporting in the central portion thereof one of said electrodes; a conductive sleeve surrounding said pair of annular insulating members, said sleeve defining in the periphery thereof an axial slot; clamp means engaging the outer surface of said sleeve to reduce its diameter and thus tightly engage said pair of annular insulating members to maintain said electrodes in a predetermined spaced relationship; and an annular detent along the inner surface of each of said pair and defining an annular surface remote from said electrodes such that it is always in the shadow of any conductive vapors generated by arcing in the space intermediate to said electrodes whereby conductive vapors generated in the space between or adjacent to the electrodes may flow between the annular detents to impinge upon the conductive sleeve without materially affecting the electrical properties of the spark gap switch.

2. A spark gap switch comprising: a pair of electrodes, mountable and spaced apart in substantially coaxial alignment; a pair of annular insulating members, separately supporting in the central portion thereof one of said electrodes; a conductive sleeve surrounding said pair of annular insulating members, said sleeve defining in the periphery thereof a coaxial slot; a pair of collar grip clamps each engaging the outer surface of said sleeve to reduce its diameter in the region of one of said annular insulating members to selectively maintain said electrodes in a predetermined location; and an annular detent along the inner surface of each of said pair of annular insulating

members extending toward the other of said pair and defining a surface remote from said electrodes such that it is always in the shadow of any conductive vapors generated by arcing in the space intermediate to said electrodes whereby conductive vapors generated in the space between or adjacent to the electrodes may flow between the annular detents to impinge upon the conductive sleeve without materially affecting the electrical properties of the spark gap switch.

3. A spark gap switch comprising: a pair of electrodes, mountable in coaxially spaced alignment with each other; a pair of annular insulating members, each supporting one of said electrodes; an electrically conductive cylindrical sleeve substantially surrounding said pair of annular insulating members and enclosing the space therebetween, said sleeve defining in the periphery thereof an expandable axial slot; clamping means engaging the outer surface of said sleeve to reduce its diameter and the gap of the slot to cause said sleeve to support said pair of annular insulating members and maintain said electrodes in a predetermined spaced relationship; and an annular detent along an axial surface of each of said pair of annular insulating members extending toward the other of said pair and defining a region remote from said electrodes such that it is always in the shadow of any conductive vapors generated by arc currents in the space between or adjacent to said electrodes whereby vapors created in the space intermediate to the electrodes may flow between the annular detents to impinge upon the conductive sleeve without materially effecting contamination of the shadow region thereby maintaining the electrical properties of the spark gap switch.

4. A spark gap switch comprising: a pair of electrodes mountable in coaxial alignment with each other; a pair of annular insulating members, each supporting one of said electrodes; an electrically conductive cylindrical sleeve substantially surrounding said pair of annular insulating members and enclosing the space therebetween; and an annular detent along an axial surface of each of said pair of annular insulating members extending toward the other and defining a region remote from said electrodes such that it is always in the shadow of any conductive vapors generated by arc currents in the space between said electrodes whereby the shadow region remains substantially uncontaminated during arcing of the spark gap switch.

5. A spark gap switch comprising: a first and a second electrode mountable coaxially in alignment with each other; a pair of annular insulating members, each supporting one of said electrodes; an electrically conductive cylindrical sleeve substantially surrounding said pair of members and enclosing the space therebetween; means for maintaining said electrodes in a predetermined spaced relationship; and an annular detent along an axial surface of each of said pair of members extending toward the other of said pair and defining an annular region remote from said electrodes such that it is always in the shadow of any conductive vapors generated by an arc.

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