Aug. 28, 1951 M. F. D. BÖCKMAN ET AL 2,565,945

PROTECTION SPARK GAP

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Fig.1

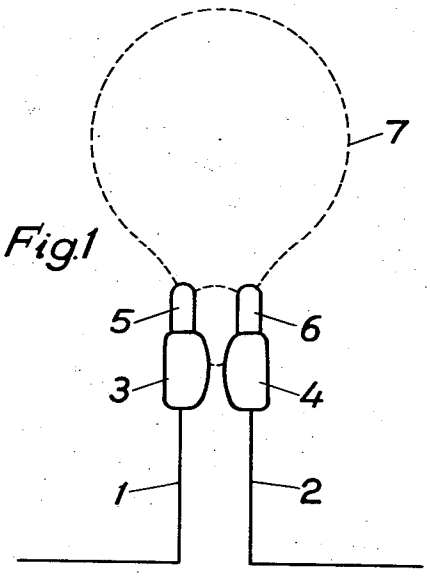


Fig.2

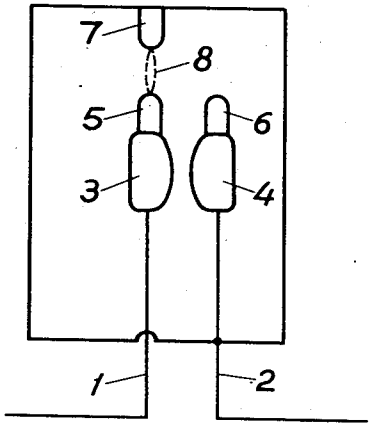
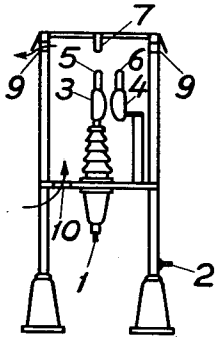


Fig.3



Inventors.
Marius F. D. Böckman
and Svend Aa. Vörts
By [illegible]
Attorney.

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PROTECTION SPARK GAP

Marius F. D. Böckman and Svend Aa. Vörts, Ludvika, Sweden, assignors to Allmänna Svenska Elektriska Aktiebolaget, Vasteras, Sweden, a Swedish corporation

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2 Claims. (Cl. 313—325)

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For the protection of electrical plants or parts of plants against incidental over-voltages, protective spark gaps can be used in combination with automatic circuit-breakers in such a way that in case of flash-over in one or several of the gaps, due to over-voltages, suitable relays automatically may give rise to definite or time-limited—often very short-term—disconnection of the part in question. Then the arc created at the flash-over in the gap will be extinguished, and the part of the plant will be ready for normal function when the voltage is connected again.

Such a gap should have a well-defined and constant ignition voltage as well as a steadily burning arc, created at the flash-over, which will not cause appreciable voltage peaks across the gap after the first ignition voltage peak. In the case of an alternating current, for instance, this should be the case without the arc having to be re-ignited every half cycle by an ignition voltage of the same magnitude as the first ignition voltage peak, as such repeated voltage peaks would damage the part of the plant intended to be protected. Finally, it is also desirable that the arc created in the gap should be limited in its geometrical extension, thereby reducing the necessary space around the gap, and facilitating an efficient shielding of the gap within reasonable dimensions, permitting the mounting of the gap outdoors without any risk of altering the ignition voltage due to precipitation or smoke or dust.

The present invention refers to a spark gap in air which fulfills the requirements mentioned above, and which is characterized by the fact that the electrodes and the conductors leading to them are arranged and shaped in such a way that the flash-over is initiated between metal surfaces, the form and distance of which determine the flash-over voltage, and then, the arc created at the flash-over is immediately, by the electromagnetic and/or thermal forces of the current brought to such a position that it burns between surfaces of a material suitable as base-point of the arc, for instance of graphite.

The invention will be further described with reference to the accompanying drawing which shows two different embodiments of the invention, in Figs. 1 and 2, and in Fig. 3 the practical arrangement of a gap according to Fig. 2.

In the gap according to the form shown in Fig. 1, the conductors are designated by 1 and 2 and the electrodes by 3 and 4, the latter being made of a metal suitable for the purpose. The

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electrodes are shaped in such a manner that a well-defined ignition voltage will be obtained. On the top the electrodes are provided with auxiliary electrodes 5 and 6 of a material, for instance graphite, which is not only suitable as a base-point for strong arcs during several seconds without being materially damaged but which will also, under the influence of the arc emit so many ions that the arc will burn continuously, i. e. without being extinguished at possible zero passages of the current. The electrodes will be arranged in such manner that the breakdown will always begin between the main electrodes 3 and 4, whereby a well-defined ignition voltage will be obtained. The conductors are, however, drawn in such a way that the arc, by the electro-magnetic forces of the current, is immediately forced to ascend to the auxiliary electrodes 5 and 6, whereby the main electrodes will be spared and obtain practically no burns, at the same time as the stability of the arc is maintained by the material of the auxiliary electrodes. The thermal arc-currents, produced by the heat production of the arc in the shown embodiment, also contribute to the rapid ascending of the arc to the auxiliary electrodes.

In the form shown in Fig. 1 the arc is forced, at arcing times exceeding 0.1 seconds, to a considerable height and to a considerable extent, 7, and the space necessary for such a gap will be rather large. It is also difficult to shield or in other way protect it against precipitation and soiling when mounted outdoors.

This drawback is eliminated by the embodiment shown in Fig. 2, where the numerals 1–6 correspond to those of Fig. 1, but where a third auxiliary electrode 7 is placed right above one of the two other auxiliary electrodes, and is in electrical contact with the other one of these electrodes. The principle is here that when the arc starts its ascending movement owing to the electro-magnetic and thermal forces of the current, it will very soon strike the third auxiliary electrode 7. As the latter is in connection with the electrode 6, the whole current will now pass between the electrodes 5 and 7, and the electrode 6 will no more be touched by any arc. In this position, however, the arc cannot be affected by any electro-magnetic forces, because the conductors to the electrode 7 are drawn symmetrically on each side of the conductor 1, and the arc will now stabilize itself in the position 8, shown in the figure. To this fact the ascending thermal air-currents further contribute, which currents now

of course are flowing in the longitudinal direction of the arc.

A spark gap according to the principle of Fig. 2 has the advantage of a relative small space demand, as the geometrical extension of the arc is very limited. Such a gap therefore may be easily enclosed in a suitable casing of conducting or insulating material to prevent soiling.

A practical design of such a gap in a casing is shown in Fig. 3. The numerals 1–7 are the same as in Fig. 2. The casing is provided with ventilation apertures 9 at the top and 10 at the bottom, but forms may be used with an entirely enclosed gap without those openings.

We claim as our invention:

1. A spark gap comprising two main electrodes spaced to constitute a calibrated protective gap, one auxiliary electrode connected to and located directly upon each one of said main electrodes, conductors leading to said main electrodes and so arranged and located that the foot points of the arc between the main electrodes are moved upwardly to the auxiliary electrodes by electromagnetic and thermal forces, a third electrode located above and spaced from the auxiliary electrode connected to one of said main electrodes, and at least two parallel conductors connecting said third electrode to the conductor leading to the other of said main electrodes, said conductors from the third electrode to the said main electrode being symmetrically displaced around the gap between the third electrode and the said auxiliary electrode in order to avoid any substantial electro-magnetic forces on the arc between these electrodes.

2. A spark gap comprising two main electrodes spaced to constitute a calibrated protective gap,

one auxiliary electrode connected to and located directly upon each one of said main electrodes, conductors leading to said main electrodes and so arranged and located that the foot points of the arc between the main electrodes are moved upwardly to the auxiliary electrodes by electromagnetic and thermal forces, a third electrode located above and spaced from the auxiliary electrode connected to one of said main electrodes, a casing enclosing the spark gap, and at least two parallel conductors connecting said third electrode to the conductor leading to the other of said main electrodes, said conductors from the third electrode to the said main electrode being symmetrically displaced around the gap between the third electrode and the said auxiliary electrode in order to avoid any substantial electro-magnetic forces on the arc between these electrodes, and said conductors forming part of the said casing enclosing the spark gap.

MARIUS F. D. BÖCKMAN.
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