W. C. ARSEM.

ELECTRIC CUT-OUT.

APPLICATION FILED FEB. 26, 1914.

1,157,919. Patented Oct. 26, 1915.

Fig. 1.

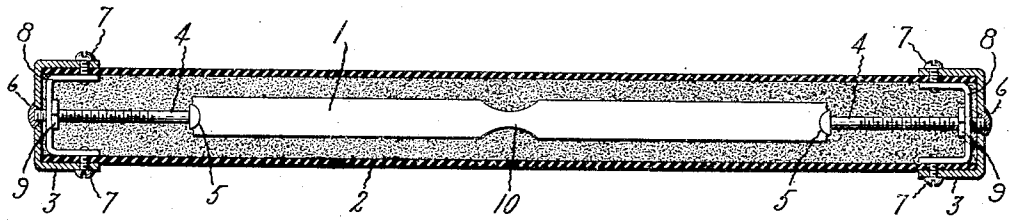
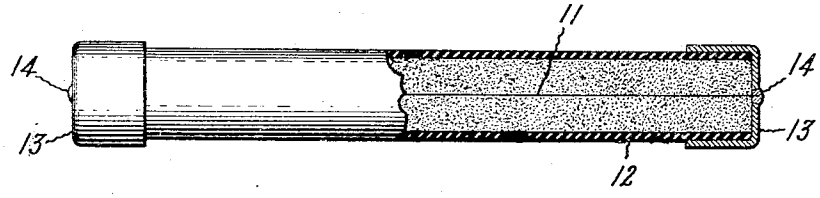


Fig. 2.



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UNITED STATES PATENT OFFICE.

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ELECTRIC CUT-OUT.

1,157,919. Specification of Letters Patent. Patented Oct. 26, 1915.

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To all whom it may concern:

Be it known that I, WILLIAM C. ARSEM, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric Cut-Outs, of which the following is a specification.

My invention relates to electric cut-outs in which the opening of a circuit under conditions of excessive current flow is brought about by overheating of a fusible conductor traversed by the current.

It is the aim of my invention to secure superior functional and operating characteristics in such cut-outs by means of a special environment for their fuse conductors. Among the advantages thus obtainable I may mention special adaptation for high voltages and small capacities; accuracy and reliability in the realization of intended capacities and circuit opening or "blowing" characteristics; substantial uniformity of fuses constructed alike within the limits of commercial conditions and methods of manufacture; delicacy as regards the percentage difference between the current which the fuse will carry continuously and that on which it will be sure to blow; and prompt, quiet blowing when the fuse conductor melts or volatilizes.

I have found that the advantages which I have mentioned and various others can be secured when the fuse conductor means is surrounded with loose particles of silicic acid in a light, voluminous form, preferably rather finely granulated or even powdered. Dense, heavy silicic acid or silicic anhydrid—as flint sand or ground quartz, for example,—is altogether unsuitable; for when a fuse conductor surrounded by such material is heated nearly or quite to its melting point by a progressively rising current, it will usually heat the surrounding material enough to render the same conductive before it is itself ruptured, and the gradual growth and cumulatively increasing conductivity of the independent path thus formed for the current will result in an ultimate rise thereof far beyond the intended maximum capacity of the fuse. While moisture not firmly held as water of crystallization or otherwise combined is undesirable as tending to cause the silicic acid to densify or even coagulate or harden under the degree of heat which it may undergo in ordinary service, water of hydrated silicic acid that is so held or combined and is liberated only at temperatures corresponding to the blowing point of the fuse seems to be beneficial in causing prompt blowing, absorbing heat, and keeping the temperature within reasonable limits.

The silicic acid with which I have obtained the best results is the hydrated acid commercially known as "Merck's silicic acid, pure, wet process" (made, I believe, by adding hydrochloric or other acid to a solution of sodium silicate or water-glass, washing the precipitate, and drying it at a moderate temperature) whose total water content as found by heating at a relatively high temperature until the weight becomes constant is about 14.16%, corresponding to the formula $H_2Si_2O_5$ or $2SiO_2.H_2O$. As this material contains an amount of very fine particles or dust sufficient to annoy those working in the room where the fuses are filled with it, I usually prefer to prepare it for use by shaking it thoroughly on a sieve of very fine bolting silk, rejecting all that passes the sieve.

For the convenience of those desiring to use my invention, I have hereinafter illustrated and described several fuse structures of the inclosed safety type in which silicic acid may be used by way of packing or filler about the fuse conductor, and I have given dimensions and other data relating to their construction for particular capacities. It is to be understood, however, that this information is merely intended as an aid in the design of fuses according to the needs of particular services, since the utility of silicic acid about a fuse conductor does not in the least depend on the use of any particular structure.

In the accompanying drawings, Figure 1 is a longitudinal sectional view of one form of fuse structure that gives good results with a silicic acid filler such as above described. Fig. 2 is a similar view showing a modified construction.

In Fig. 1 I have shown a simple construction especially suitable for inclosed fuses of moderate capacities. As here shown, the fuse conductor means 1 is arranged within a cylindrical tube or shell 2 and is connected to ordinary terminal caps 3 by threaded parts 4 soldered thereto at 5 and in holes in

the caps at 6. Each of the caps 3 is removably secured in place by screws 7 that extend through it and through the walls of the tube 2 and are threaded into the ends of a U-shaped part 8 itself threaded on the part 4 and held in place by a lock-nut 9. The Merck's hydrated silicic acid filler can be properly packed by merely pouring it in and slightly shaking or tapping the tube 2, care being taken to have the tube quite full when sealed up. The conductor means 1 of a fuse thus constructed and filled suitable for circuits of as high as 2400 volts and adapted to carry 30 amperes and blow within one minute on 50% overload may consist of a single strip or ribbon of commercial zinc 8 inches long, 3 mils thick, and $\frac{1}{2}$ inch wide, with a short middle portion narrowed as shown at 10 to $\frac{3}{16}$ inch, and the casing may be a fiber tube about 1 inch in external diameter, $\frac{1}{16}$ to $\frac{1}{8}$ inch thick, and 12 inches long.

In Fig. 2 I have shown an ordinary and simpler construction suitable for inclosed fuses of relatively small capacities. Except in the case of very small fuses, I usually prefer to make the fuse conductor 11 in the form of a very thin ribbon, just as in the fuse shown in Fig. 1, since I find that if the conductor 11 is thin enough in proportion to its width the very material deformation toward a cylindrical form that it suffers as the result of capillary force or surface tension when it melts causes it to blow more promptly and sharply than would otherwise be the case. Contrary to what might, perhaps, be expected, the silicic acid filler does not seem to interfere with this capillary effect, but rather tends to break the molten ribbon by its presence and hasten the blowing.

For rated capacities not exceeding about 10 amperes, superior results can be obtained by making the fuse conductor 11 of metallic cadmium. Such a fuse conductor to carry 4 amperes and blow almost instantly on 50% overload, suitable for 500-volt circuits or for lower voltages, can be made of ribbon of commercial cadmium 2 mils thick, 65 mils wide, and $4\frac{1}{4}$ inches long. The casing for this conductor may be a fiber tube about $\frac{5}{8}$ inch in external diameter and $\frac{1}{16}$ inch thick, the filler of prepared silicic acid such as above mentioned being packed as in the case of the fuse of Fig. 1 and with the same precautions. For 250-volt circuits and a blowing point of the same percentage overload, a 2 ampere fuse can be made of about $1\frac{5}{8}$ inches of 2 mil ribbon 26 mils wide, the fiber tube casing being about $\frac{1}{2}$ inch to $\frac{7}{16}$ inch in external diameter and $\frac{1}{16}$ inch or more thick, and the filler being unsieved hydrated silicic acid to the amount of about 0.78 gram. Again, for circuits of about 250 volts or less, a fuse to carry 0.4 ampere and blow almost instantly on 0.55 ampere can be made with cadmium wire 2.2 mils in diameter and about $1\frac{1}{2}$ inches long, the casing being of the same fiber tubing as that of the 2 ampere fuse, and the filler being likewise unsieved hydrated silicic acid.

The uniformity and the action of fuses such as illustrated in Figs. 1 and 2 are improved by careful centering of the fuse conductor means in the casing, by uniform packing of the filler, by not using too much filler or packing it too tight (the more or the tighter the filler, the longer the blowing time of the fuse), and by otherwise taking care that the heat capacity and heat insulation shall be uniform both all around the conductor and throughout its length,—as well as, also, in different fuses. If these points are attended to at all, it will be found that the silicic acid filler will not form an independent conductive path for the current under any circumstances,—not even, for example, in fuses of as high as 100 amperes capacity for direct current circuits of voltages as high as 1800,—and that when the fuse blows this filler acts to diffuse the liquid or vaporous metal and so counteracts any explosive tendency.

From the foregoing description it will be evident that besides affording various functional and practical advantages such as above set forth, my invention greatly enlarges the field of usefulness for ordinary fuses; for whereas with fillers such as were previously used, fuses for direct current circuits were practically limited to voltages not exceeding 1200, and were found more or less unsatisfactory even for this voltage, with my silicic acid filler such fuses can readily be used on direct current circuits of double this voltage. Incidentally, it may be remarked that with a silicic acid filler and a cadmium fuse conductor a reliable, delicate fuse of as low as 0.4 ampere rated capacity can readily be made, as already described; whereas formerly, with other fillers and fuse conductor metals, the so-called one ampere fuse, deemed the smallest practicable, might when new carry anywhere from its rated blowing current of $1\frac{1}{2}$ amperes up to 3 amperes or over without blowing, and after being several times subjected for a few seconds to currents approaching its initial blowing current might even stand five amperes or more continuously and some seven amperes momentarily. While the use of a filler may not be necessary to the practical operativeness of such small fuses, my silicic acid filler does improve their operating characteristics.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. An electric fuse having its fuse conductor surrounded by loose, dry particles of hydrated silicic acid.

2. An electric fuse having its fuse con-

ductor surrounded by loose particles of hydrated silicic acid in a light, voluminous form.

3. An electric fuse having its fuse conductor surrounded by loose particles of silicic acid hydrated in substantially the proportion of one molecule of water to two of acid, and in a light, voluminous form.

4. As a packing or filler for electric fuses, hydrated silicic acid in the form of loose, dry particles, light and highly voluminous.

In witness whereof I have hereunto set my hand this 25th day of February 1914.

WILLIAM C. ARSEM.

Witnesses:
F. CASPER ZAPF,
HELEN ORFORD.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."