April 6, 1943. F. WEIL 2,316,036

ELECTRIC CIRCUIT INTERRUPTING DEVICE

Filed June 5, 1941

Fig. 1.

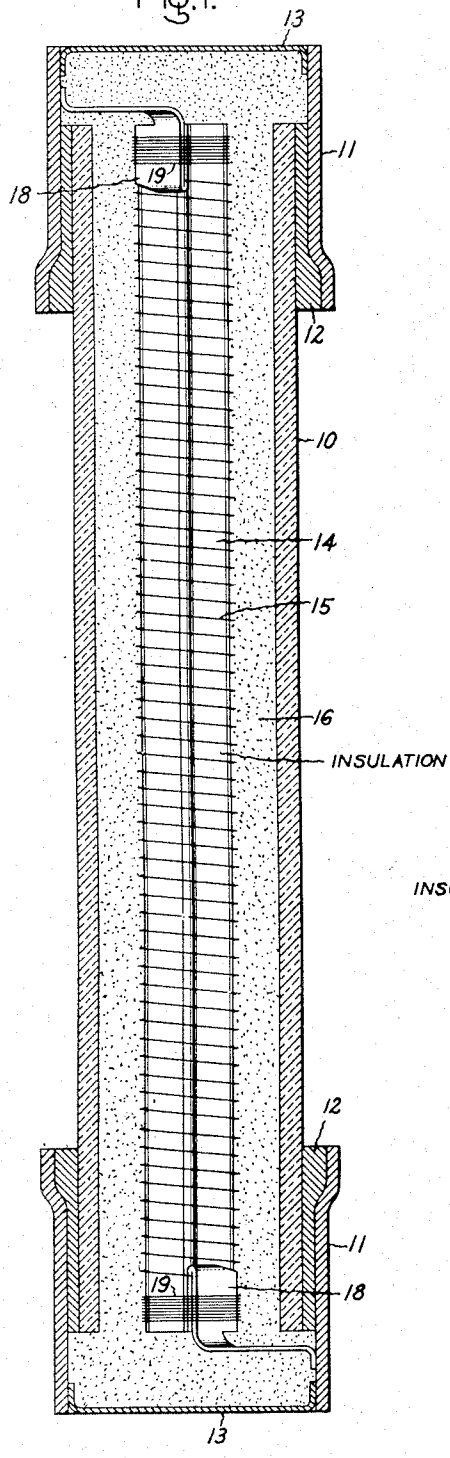
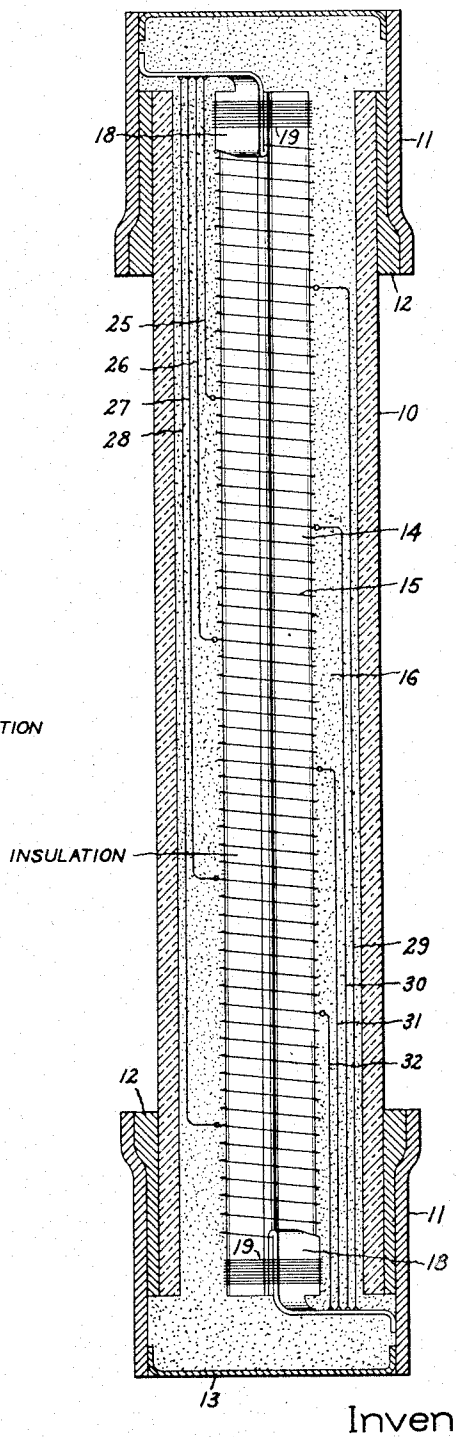


Fig. 2.



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ELECTRIC CIRCUIT INTERRUPTING DEVICE

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6 Claims. (Cl. 200—120)

The present invention relates to electric circuit interrupting devices, particularly for high voltages, and of the type embodying an interrupting element having a long fusible section embedded in an inert granular arc quenching material and which fusible section is designed to fuse and dissipate ultimately throughout substantially the whole of its length upon subjection thereof to excess current of large magnitude, such as a severe short circuit current.

In the operation of fuses of this type it has been observed that if the entire fusible section dissipates substantially instantaneously under severe excess current conditions, then undesirably high voltage surges are likely to occur due to the sudden insertion of the maximum high value resistance into the current path. To avoid such voltage surges, various means have been proposed such as that shown in the United States Patent No. 2,157,907 issued May 9, 1939, to K. A. Lohausen and assigned to the General Electric Company, the assignee of the present invention. The device disclosed in that patent comprises a fusible interrupting element having a varying cross section so that under a severe overcurrent, a progressive or stepped dissipation of the fusible section occurs whereby in effect the ultimate high resistance is inserted gradually into the current path. The rate of current change during the interruption is thereby somewhat delayed and the voltage disturbance correspondingly reduced.

It is an object of the present invention to provide a new and improved electric circuit interrupting device of the general type described and which will operate without causing a high voltage surge, and which does not require the use of a fusible element having a graduated cross-sectional dimension or varying end-to-end resistance.

It is a further object of the present invention to provide a new and improved high voltage electric circuit interrupting device having a relatively long fusible element which is so dimensioned that it functions first to insert a gradually increasing value of resistance into the circuit and subsequently to interrupt the current without causing a high voltage surge on the line.

Another object of the present invention is to provide a new and improved high voltage electric circuit interrupting device including a relatively long fusible element so arranged that during normal current conditions it presents a relatively low resistance path and upon the occurrence of an excess current, a relatively high resistance path immediately prior to the fusing thereof.

For a consideration of what I believe to be novel and my invention, attention will be directed to the following description and the claims appended thereto taken in connection with the accompanying drawing, in which Figs. 1 and 2 are longitudinal cross-sectional views of two modifications of electric circuit interrupting devices constructed in accordance with the invention.

The present invention is based upon the discovery that high voltage fuses of the type mentioned provided with a fusible element which is several times longer than is necessary on account of the operating voltage and the required interrupting capacity alone will interrupt relatively heavy currents without causing high voltage surges. Upon a first consideration this would seem to be contradictory to certain previously known observations indicating that the overvoltages are increased as the fusible conductor is lengthened. This is not true, however, for very long lengths of fusible conductors. In the operation of this type of fuses, it is understood that two phenomena occur during the current interruption, the first being the increase in the specific resistance of the fusing conductor resulting from the rise in the temperature and the melting thereof, and the second being the ultimate vaporization of the conductor. Fuses as heretofore constructed, which are dimensioned in accordance with the required interrupting capacity, normally have such short fusible conductors that the increase in the specific resistance has substantially no effect as regards the reduction of current. The vaporization process which follows, and which is more abrupt, will dampen the current with a rapidity corresponding roughly to the length of the vaporizing conductor and which results in a correspondingly high overvoltage.

In accordance with the present invention, however, the fusible element or conductor of the circuit interrupting device is lengthened not only without increasing the overvoltage surges but actually, as has been borne out by tests, reduces the overvoltage surges to relatively low values. It has been found that if the fusible conductor is made so long that its increasing resistivity produces, just prior to the beginning of the vaporization process, a considerable reduction in the current, this phenomenon proceeds so gradually that the overvoltage occurring therefrom entails only a fraction of the overvoltage which occurs

in the case of fusible conductors of normal length. Moreover, the reduction in current brought about in this manner is so effective that the ensuing vaporization is incapable of producing noticeable overvoltages.

The modification of the interrupting device shown in Fig. 1 has a tubular enclosing casing 10 which is constructed of glass, porcelain, or other suitable insulating material. Metallic terminal ferrules 11 are secured respectively on the opposite ends of the casing by means of any suitable form of glass-to-metal seal indicated at 12. The ends of ferrules 11 are closed by caps 13 sealed in place, although if desired the caps may be made integrally with the ferrules. An elongated insulating support or core 14 comprised of high heat resisting ceramic or other suitable material, extends longitudinally in the casing. This core, preferably X-shaped in cross section, serves to support a fusible current interrupting conductor 15 which is spirally wound thereon. The opposite ends of the element 15 are secured to terminals 18 bound to the ends of the core 14 as by tie wires 19. Extensions of the terminals 18 are bent over and soldered or brazed to the ferrules. The interior of the casing 10 around the core 14 is filled with an inert granular arc quenching material 16, such as sand or pulverized quartz, which embeds the current interrupting element.

For reasons as explained above, the fusible element 15 is of a length several times greater than that required merely by reason of the particular operating voltage and current interrupting capacity for the device. It is of such a length that the resistivity, or specific resistance thereof, following the initial application of an excess current increases to such a value before the ultimate vaporization thereof that a substantial reduction in current is effected over that which would normally occur with a fusible element of normal length. The exact length for the fusible element will of course depend upon the particular material used, the line voltage and the current interrupting capacity for the device.

It is appreciated that it is not practicable to build into high voltage fuses fusible elements of great length, except in the case of those rated for very low currents. While it may be possible to mount a single fusible conductor of a considerable length, according to the invention, within a tube holder of conventional dimensions, it is not possible to do so when, for the case of higher current ratings, a number of fusible conductors must be connected in parallel, as is usually the case. The latter devices would require holder tubes of very long dimensions, otherwise the fuse device would be subject to excessive temperature rises, even under normal service conditions.

According to a second embodiment of the invention, the last mentioned disadvantage is avoided by bypassing the fusible element, which has been made very long for the purpose of lowering the overvoltages, by means of one or more parallel conductors, which in normal service conduct the current, and in the case of an excess current condition are the first to melt, so that the current interruption, is assumed by the long fusible element. It has been proved advantageous to connect a number of conductors in parallel from the opposite end terminals to various spaced intermediate points of the long current interrupting fusible element.

In the second modification of the invention illustrated in Fig. 2, a plurality of fusible conductors 25, 26, 27, and 28 are connected between the upper terminal 18 and spaced points on the current interrupting element 15. Similarly, a plurality of fusible conductors 29, 30, 31, and 32 are connected between the lower terminal 18 and other spaced points on the interrupting element 15. Neglecting slight deviations at the ends of the conductor system, the current during normal conditions will flow evenly distributed from one end, for example the upper, through the conductors 25 to 28 into the conductor 15. The branch current in each conductor 25 to 28 will divide at the point of connection to the fusible conductor 15 and both halves will continue to flow in the conductor 15 but in opposite directions. Thus, the current flowing into the conductor 15 from the parallel conductors 25 to 28 is carried off by the conductors 29 to 32 in a similar manner. It will be apparent that all parts of the conductor 15 which lie between two points of connection are thus connected in parallel. If the unbalance at the ends of the fusing conductor system is disregarded, it can be stated that the current load of the conductor 15 is approximately half as great as the current load in each of the individual conductors 25 to 32, inclusive.

In the event of an overcurrent condition, such as a short circuit, the interruption of the conductor 15 will be preceded by the interruption of the conductors 25 to 32, inclusive, it being understood that these latter conductors are so dimensioned that they will fuse substantially instantaneously upon the application of an overcurrent condition and before the fusing of the element 15. Thus, if the conductors 25 to 32, inclusive, are of the same material as the element 15, then the parallel fusible conductors should have a cross section smaller than twice the cross section of the conductor 15. After the disconnection of the conductors 25 to 32, inclusive, all of the sections of the element 15 are connected in series, and the conductor 15 represents a direct interconnection between the opposite terminals of the device. As a result one attains a substantial lowering of the overvoltage created during the disconnection, which would occur if conductors 25 to 32 were interrupted. Since the conductor 15 is very long, the current flowing through it can then be interrupted without substantially any overvoltage.

Having described the principle of operation of my invention in what I consider to represent a preferred embodiment thereof, I desire to have it understood that the specific form shown is merely illustrative and that the invention may be carried out by other means.

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

1. An enclosed high voltage fuse of the type having a fusible element embedded in a granular inert arc extinguishing medium, said fuse being provided with means for precluding the occurrence of an excess voltage condition during the circuit interrupting procedure, said fusible element having a length such that following the initial application of the excess current condition and prior to the vaporization thereof the specific resistance of said element will increase to such a value as to effectively reduce the value of current flow prior to the insertion of maximum resistance in the circuit by the vaporization of said element.

2. A high voltage circuit interrupting device including an insulating casing, an insulating sup-

port arranged in said casing, a circuit interrupting element having a long fusible section designed to dissipate ultimately throughout substantially the whole of its length, a granular inert arc quenching material surrounding and embedding substantially the whole of the length of said fusible section, said fusible section having a length at least several times greater than the length normally required for the voltage and interrupting capacity of the particular device, said length being furthermore such that following the initial application of an excess current condition thereto the specific resistance thereof will be such a value as will effect a substantial reduction in the current flow therethrough prior to the insertion of maximum resistance into the circuit by the dissipation of said fusible element.

3. In a high voltage circuit interrupting device, a fusible circuit interrupting element designed to dissipate ultimately throughout substantially the whole of its length upon subjection to an excess current condition, a pair of terminals for said element, a plurality of fusible conductors connected to each of said terminals and to different points in said element connecting substantially equal portions of said element in parallel between said terminals, said conductors being fusible prior to said element upon the occurrence of an excess current condition.

4. In a high voltage circuit interrupting device, including a long fusible circuit interrupting element, end terminals for said element, a fusible conductor connected to each of said terminals and to different intermediate points of said element said points dividing said element into substantially equal portions, said conductors being fusible prior to said element upon an overcurrent condition.

5. In a high voltage circuit interrupting device, a circuit interrupting element having a long fusible section designed to dissipate ultimately throughout substantially the whole of its length upon subjection to a short circuit current, a pair of terminals for said element, a fusible conductor connected to each of said terminals and to different spaced intermediate points of said fusible section whereby said section is divided into a plurality of substantially equal portions connected in parallel between said terminals, said fusible conductors effecting a relatively low resistance path between said terminals for normal operation, said conductors being fusible prior to said interrupting element whereupon said interrupting element will be connected in series between said terminals and present a relatively higher resistance path therebetween, the length of said fusible section being such that the specific resistance of said section will effect a substantial reduction in the current flow following the fusing of said conductors and prior to the vaporization of said section.

6. In a high voltage fuse of the current limiting type, a casing, an inert arc extinguishing medium in said casing, and a fusible conductor embedded in said arc extinguishing medium and having a length several times greater than that necessary merely for the reason of the operating voltage and the required interrupting capacity alone, for precluding the occurrence of overvoltages on said fuse during circuit interruption.

FRITZ WEIL.