

May 9, 1939.

K. A. LOHAUSEN

2,157,907

FUSE

Filed Nov. 26, 1935

Fig. 3.

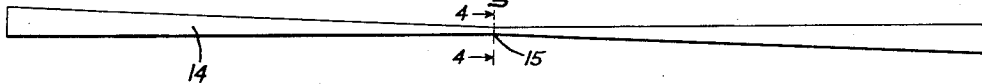


Fig. 4.



Fig. 5.

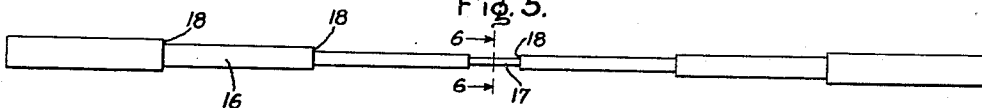


Fig. 6.



Fig. 1.

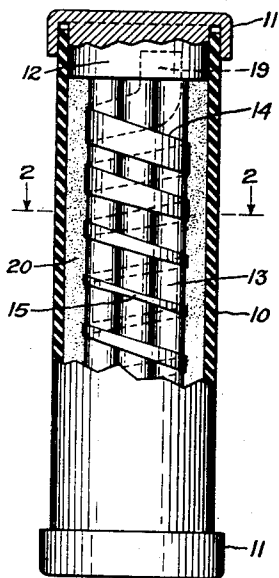
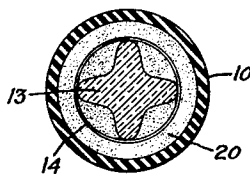


Fig. 2.



Inventor:
Karl A. Lohausen,
by *Harry E. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

2,157,907

FUSE

Karl August Lohausen, Berlin-Oberschoneweide,
Germany, assignor to General Electric Com-
pany, a corporation of New York

Application November 26, 1935, Serial No. 51,694
In Germany December 11, 1934

5 Claims. (Cl. 200—120)

The present invention relates to fuses and particularly to improvements in the construction of enclosed high tension fuses of the type wherein the fusible conductor is embedded in an arc quenching material.

High tension fuses are known in which a fusible conductor is embedded in a quenching material which, upon dissipation of the conductor due to excess current of large magnitude, as upon short circuit, is capable of exerting a powerful current reducing and arc-quenching action resulting in interruption of the current in a half cycle at the latest in case of alternating current. The term "current limiting" has been applied to fuses of this character because of their ability sharply to limit an initial short circuit current peak to a magnitude well below that which an electric system, in which such fuse is connected, otherwise is capable of producing. It is believed that this action takes place either due to an extremely rapid cooling of the arc by the surrounding quenching material, or due to formation of a high resistance fused shell of quenching material immediately around the arc path in such manner that the fused shell takes over the current, reduces the current magnitude due to the high resistance and finally interrupts the current flow. In fuses of this character, as heretofore constructed, the fusible conductor is dissipated instantly throughout its whole length upon subjection thereof to excess current of large magnitude, since the conductors heretofore employed in such fuses have had uniform cross-section over their whole length.

Such instant dissipation of the fusible conductor throughout its whole length brings about violent and sudden changes from the normal conditions existing prior to subjection of the conductor to the excess current. A high resistance, due either to the action of the arc or to the resistance of the fused shell above referred to, is suddenly interposed in the path of the current. The resultant sudden change in the value of current flow causes severe over-voltages which are greater, the greater the value of the resistance interposed and the greater the current flowing at the moment the dissipation of the fusible conductor takes place. The fusing current is determined in the main by the cross sectional area of the fusible conductor and also by the nominal current. On the other hand, the resistance of the arc or the fused shell of the quenching material must have a definite minimum value in order to enable the quenching to take place. In consequence of this a considerable over-voltage cannot be avoided, particularly in the case of fuses carrying a high nominal current. This holds good for both high tension fuses having only one main fusible conductor and

for those having main and secondary fusible conductors.

A principal object of the present invention is therefore the provision of a high tension current limiting fuse construction wherein the fusible conductor or conductors are so formed that they do not dissipate instantly over their whole length and that the quenching resistance, whether due to the arc resistance or to the resistance of the fused shell of the quenching material, is not interposed suddenly to its full magnitude in the path of the current, and whereby the difficulties above outlined are avoided.

A more detailed understanding of the manner in which the invention is carried out may be had from the following description taken in conjunction with the accompanying drawing in which Fig. 1 illustrates an exemplary fuse construction embodying the present invention; Fig. 2 represents a cross-section of the fuse of Fig. 1, taken along the line 2—2; Fig. 3 illustrates a form of fusible conductor suitable for incorporation in the fuse of Fig. 1 in the carrying out of the present invention; Fig. 4 is an enlarged cross-sectional view of the conductor of Fig. 3 taken along the line 4—4; Fig. 5 illustrates a second form of fusible conductor and Fig. 6 is an enlarged cross sectional view of the conductor of Fig. 5 taken along the line 6—6.

In Figs. 1 and 2 of the drawing, 10 designates a tubular enclosing casing constructed of suitable insulating material. This casing is provided with metallic end caps 11 fastened to the casing in any suitable manner and having connection terminals 12 extending a short distance into the casing. Within the casing is disposed a conductor carrier 13 of glass, ceramic material or the like, having suitable shape such as, for example, the star shape form illustrated. About the carrier is wound spirally a fuse element which may comprise either a single fusible conductor or a plurality of parallel connected fusible conductors. In the embodiment illustrated in Figs. 1 and 2 the fuse element consists of a single conductor 14 which is shown more clearly in Figs. 3 and 4 as comprising an elongated strip of thin metallic foil having a reduced width at the point 15 midway between the ends thereof with the width increasing continuously toward both ends.

Another form of fusible conductor suitable for the practice of the present invention is shown in Figs. 5 and 6 and comprises a variable cross-section thin round wire 16 having its smallest cross-section substantially midway between the ends as shown at 17 with the cross-section increasing both ways from the middle to the ends by successive stages or steps indicated at 18. It may be desirable to construct the wire type of conductor to have transverse cross-sections of other than circular form with the cross-section in-

creasing from the reduced portion towards the ends continuously rather than by successive stages.

The carrier 13 with the fuse element 14 are disposed within the casing 10 and the ends of the fuse element are connected in any suitable manner to the terminals 12 of the end caps 11 as indicated at 19. Prior to the fastening of at least one of the end caps onto the casing, the interior of the casing is filled with a pulverulent or sandy quenching material 20 which completely surrounds or embeds the carrier and the fusible conductor. It has been found that quartz in granular or sandy form, and similar relatively finely divided materials of high dielectric strength and which are relatively inert or non-gas producing at the arc temperatures likely to be encountered, are most efficient as fillers for producing the desirable current limiting action previously referred to. However, it is contemplated that the present invention may be practiced to advantage for limitation of voltage surges also with fuses employing other filler materials which may be found capable of exerting a current limiting action of greater or less effectiveness than those referred to above.

When the fuse constructed in accordance with the present invention is subjected to an excess current of large magnitude, such as on short-circuit, the fusible conductor begins immediately to fuse and dissipate at its weakest point, which is the reduced portion, and an arc forms which results in the fusing of the surrounding material and the interposing of a relatively low resistance in the path of the current at this point. This action becomes stronger and the resistance increases as the dissipation of the fusible conductor progresses towards the ends. In the case of the fusible conductor of the type indicated by the numeral 14, this increase in resistance to a final value capable of interrupting the current flow is substantially continuous while in the case of the fusible conductor designated by the numeral 16 the increase in resistance is by gradual stages or steps. In this manner sudden changes in the value of current flow are prevented and violent stresses upon the electrical equipment connected in circuit with the fuse are avoided.

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

1. A high tension fuse of the current limiting type including in combination, a conductor adapted to dissipate throughout a fusible section of considerable length, as distinguished from dissipation only at a point of reduced cross-section, upon subjection of the fusible section to excess current of large magnitude, and an arc-quenching medium surrounding said fusible section and being of a form and composition capable, upon subjection of the fusible section to excess current of large magnitude, of exerting a current limiting action of such power as to cause voltage surges, said fusible section increasing in cross-section from a portion of reduced cross-section to a portion of relatively larger cross-section, thereby to insure progressive dissipation of said fusible section from said reduced portion to said larger portion with consequent progressive insertion of resistance into the current path upon subjection of the fusible section to excess current of large magnitude.

2. In a fuse of the current limiting type, the combination of a body of relatively finely divided inert arc-quenching material and a conductor

embedded in said material, which said conductor is adapted to dissipate throughout a fusible section of considerable length, as distinguished from dissipation only at a point of reduced cross-section, upon subjection of the fusible section to excess current of large magnitude, said fusible section decreasing in cross-section from spaced apart portions of relatively large cross-section to an intermediate portion of reduced cross-section, thereby to insure dissipation of said fusible section progressively from said reduced cross-section portion to said large cross-section portions with consequent progressive insertion of resistance into the current path upon subjection of the fusible section to excess current of large magnitude.

3. In a fuse of the current limiting type, the combination of a body of sand and a conductor embedded in said sand, which said conductor is adapted to dissipate throughout a fusible section of considerable length, as distinguished from dissipation only at a point of reduced cross-section, upon subjection of the fusible section to excess current of large magnitude, said fusible section decreasing in cross-section from spaced apart portions of relatively large cross-section to an intermediate portion of reduced cross-section, thereby to insure dissipation of said fusible section progressively from said reduced cross-section portion to said large cross-section portions with consequent progressive insertion of resistance into the current path upon subjection of the fusible section to excess current of large magnitude.

4. In a fuse of the current limiting type, the combination of a body of relatively finely divided inert arc-quenching material and a conductor embedded in said material, which said conductor is adapted to dissipate throughout a fusible section of considerable length, as distinguished from dissipation only at a point of reduced cross-section, upon subjection of the fusible section to excess current of large magnitude, said fusible section decreasing in cross-section by stages from spaced apart portions of relatively large cross-section to an intermediate portion of reduced cross-section, thereby to insure dissipation of said fusible section progressively from said reduced cross-section portion to said large cross-section portions with consequent progressive insertion of resistance into the current path upon subjection of the fusible section to excess current of large magnitude.

5. In a high tension fuse of the current limiting type, the combination of a body of relatively finely divided inert arc-quenching material, and a conductor embedded in said material, which said conductor is designed to fuse and dissipate ultimately throughout the whole length of a fusible section of considerable length, as distinguished from fusion and dissipation only at a point or spaced points of reduced cross-section, upon subjection of the fusible section to excess current of large magnitude; said fusible section including within its length portions of different cross-sectional area such that, upon subjection of the fusible section to excess current of large magnitude, the larger cross-section portion of the fusible section dissipates subsequently to dissipation of the smaller cross-section portion of the fusible conductor with resultant progressive insertion of resistance into the current path.

KARL AUGUST LOHAUSEN.