Dec. 17, 1957 E. W. SUGDEN 2,816,989

ELECTRIC FUSES

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Fig. 1.

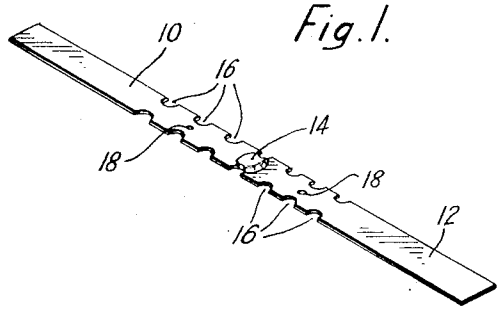


Fig. 2.

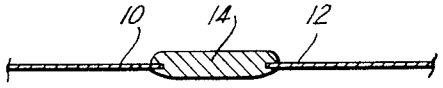


Fig. 3.

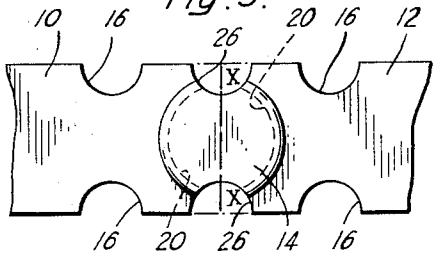
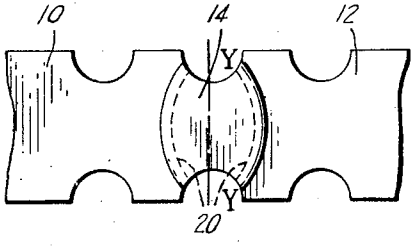


Fig. 4.



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Fig. 5.

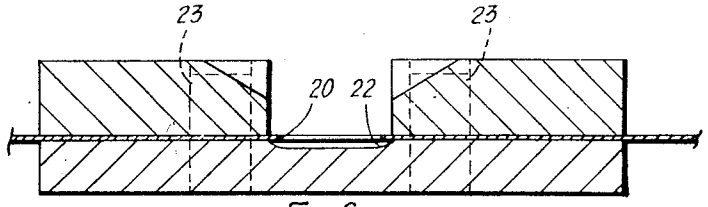


Fig. 6.

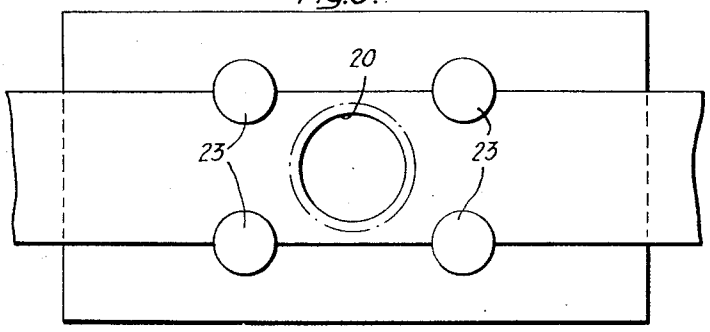


Fig. 7.

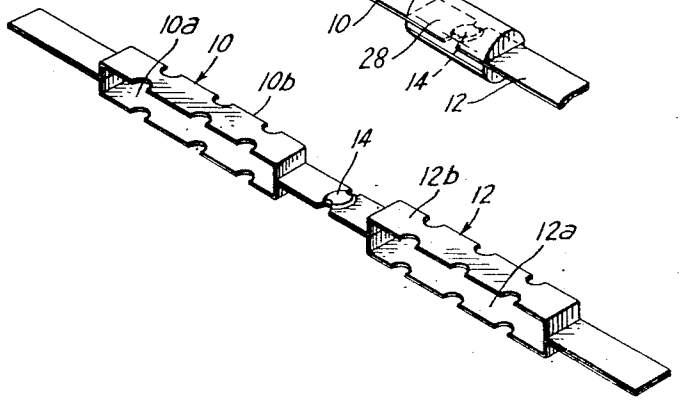


Fig. 8.

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ELECTRIC FUSES

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6 Claims. (Cl. 200—135)

This invention relates to electric fuses and more specifically to bi-metallic electric fuse links comprising a pair of high melting point elements in the form of strips arranged end to end and connected together by a low melting point element. Fuse links of this kind are described, for example, in British specifications Nos. 669,378 and 673,002.

It has been found that when such fuse links are embedded in arc-quenching powder and particularly when the high melting point elements are made of copper, the low melting point element tends to remain suspended between the opposing ends of the high melting point elements after it has been brought gradually to a molten condition by an electric current slightly in excess of minimum fusing current passing through the link. Once this "bridge" has been formed, an excessive high current must be passed through the fuse link before the molten metal will disperse.

The aim of the present invention is to provide a fuse link in which the gap between the high melting point elements is readily cleared once the low melting point element has been brought to its melting point.

According to the invention, the opposing ends of the high melting point elements are curved so as to form a generally circular or elliptical gap between them, and the low melting point element which fills this gap has a width to thickness ratio of at least 2:1, that is to say, the low melting point element is as thin as is consistent with its being cast in a simple die.

Preferably, the width to thickness ratio of the low melting point element is at least 5:2.

A fuse link having these characteristics is found to be free from the defect mentioned above. The thinness of the low melting point element enables the maximum use to be made of the surface tension of the element in helping to clear the gap between the high-melting point elements, and the curved ends of the latter provide a long "line of contact" with the low melting point element which makes for good conduction of heat and current between the respective elements.

It is desirable that the low melting point element be attached to both faces of each high melting point strip rather than to one face alone, as the latter form of connection is inferior in current and heat conductivity and, in addition, reduces the surface tension of the molten insert. Moreover, as the insert is preferably provided with a boric acid coating, it is advisable to avoid connecting the insert to one face only of each of the high melting point elements as this gives rise to undesirable distorting forces in the die generally used for coating the insert with boric acid.

In order that the invention may be thoroughly understood, a number of fuse links in accordance with it will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a fuse link in accordance with the invention;

Figure 2 is an enlarged vertical section taken through part of the fuse link shown in Figure 1;

Figure 3 is a plan view of the fuse link part shown in Figure 2;

Figure 4 is a view similar to Figure 3 of a second form of fuse link;

Figure 5 is a view in section of apparatus for manufacturing fuse links in accordance with the invention;

Figure 6 is a plan view of the apparatus shown in Figure 5;

Figure 7 is a perspective view of another form of fuse link in accordance with the invention; and

Figure 8 is a perspective view of part of a fuse link in which the low melting point element is coated with boric acid.

The fuse link shown in Figures 1–3 comprises a pair of high melting point strips **10, 12** of tinned copper arranged end to end and connected together by a low melting point element **14** of lead-tin alloy. The strips **10, 12** are provided with portions of reduced cross-section formed by notching or punching the strips at **16** and **18**. These portions serve to localise the points on the strips which "blow" on the occurrence of a heavy overload and to minimise the current admitted by the fuse prior to the commencement of circuit interruption.

As can be seen from Figure 2, the lead-tin alloy insert **14** is relatively thin, and the width to thickness ratio (the width being measured along the line X—X which is the least width of the insert) is about 3:1. I have found that the lower limit of the width to thickness ratio is fairly critical. If the ratio is below 2:1 the results obtained are not generally satisfactory, and for best results the ratio should not be less than 5:2.

Another feature of importance is that the opposing ends of the high melting point elements **10, 12** are curved as shown at **20** in Figure 3, which allows an efficient transmission of heat and current to take place between the various parts of the link. In this connection, I have found that a substantially square insert joining together two strips of high melting point having a substantially rectangular gap between them does not give good results. The curved ends of the strips **10, 12** need not always be circular as shown in Figure 3, but can also be shaped as shown in Figure 4 to provide an elliptical gap between them.

It will be noted that the insert **14** is also notched, not for the purpose of influencing the behaviour of the fuse link, but incidentally in the course of manufacture of the link. Figures 5 and 6 illustrate the manner in which the link is made, and the manufacture of a 60 amp. fuse link in accordance with the invention will now be described with reference to those figures.

The link is formed from a single strip of copper having a circular hole **20** (see Figures 3 and 6) about 0.22" in diameter lying midway between its ends, the diameter of the hole being about three-quarters the width of the strip. After the notches **16** and the holes **18** have been punched in the strip, it is located in a die **22** with the aid of vertical posts **23** which fit into the notches **16**, and the hole **20** is filled with an insert **14** of molten lead-tin alloy having a diameter of about 0.28". The insert solidifies with a substantially flat top (see Figure 2) and the narrow portions of the strip lying on either side of the hole **20** are then cut away as shown at **26** in Figure 3, together with any lead-tin alloy lying thereon. The single strip is thus converted into two separate copper strips **10, 12** joined by a lead-tin insert **14** which is notched on either side.

The casting of the insert must be carried out with considerable care. The shape of the die is such that the molten metal is made to adhere to both faces of the copper strip and the ratio of width to thickness of the

insert 14 is higher than is customary in bi-metallic fuses. I have found that the thinner the insert 14, the less is its tendency to bridge the gap between the high melting point elements 10, 12 once it has been brought gradually to a molten condition by the passage of current through the link. This, I believe, is due to the fact that the surface tension of the molten insert is capable of drawing the greater part of the insert back on to the strips of high melting point. This surface tension is increased if the insert is made to adhere to both faces of the copper strip rather than to one face alone.

It has already been stated that the lower limit of the width of thickness ratio of the insert is fairly critical, and must not be below 2:1. In the 60 amp. fuse link described above, an insert having a width of 0.2" (measured along the line Y—Y which is the least width of the insert) and a maximum thickness of 0.08" has proved very satisfactory in use.

I have tested fuse links in accordance with the invention having ratings other than 60 amps. A 100 amp. fuse link having an insert measuring 0.31" across and 0.09" in thickness, i. e. having a width to thickness ratio of the insert over 3:1, has given excellent results.

Although the specific example described above comprises two single high melting point elements arranged end to end, the invention may equally well be applied to fuse links having two pairs of high melting point elements, the two strips of each pair being arranged in parallel. An example of such a fuse link is shown in Figure 7, where the fuse link comprises two pairs of high melting point elements 10, 12, each pair consisting of two strips 10*a*, 10*b* and 12*a*, 12*b* arranged in parallel.

The insert 14 is preferably coated with boric acid in the final stage of manufacture as shown at 28 in Figure 8. It is emphasized that the invention is directed towards fuse links which are intended to be embedded in arc-quenching powder as it is only then that the difficulty which the invention aims at solving is likely to arise.

I claim:

1. An electric bi-metallic fuse link comprising a pair of high melting point elements in the form of strips arranged end to end, flat arcuate end portions on the adjacent ends of said strips, each of said arcuate end portions being less than a semi-circle in extent, a low melting point element connecting said strips together, said low melting point element having a minimum width to maximum thickness ratio of at least 2:1, the shape of the gap between said arcuate end portions and the shape of said low melting point element being circular, the peripheral edge of said low melting point element overlapping said arcuate end portions by a comparatively small amount, the diameter of said low melting point element being less than the width of said strips.

2. An electric bi-metallic fuse link comprising a pair of high melting point elements in the form of strips arranged end to end, flat curved end portions on the adjacent ends of said strips, a low melting point element connecting said strips together, said low melting point element having a minimum width to maximum thickness ratio of at least 2:1, the shape of the gap between said curved end portions and the shape of said low melting point element being elliptical, the peripheral edge of said low melting point element overlapping said end portion by a comparatively small amount, the maximum width of said low melting point element being less than the width of said strips.

3. An electric bi-metallic fuse link comprising a pair of high melting point elements in the form of strips arranged end to end, flat arcuate end portions on the adjacent ends of said strips, each of said arcuate end portions being less than a semi-circle in extent, a low melting point element of less width than the width of said strips having correspondingly curved edges connecting said strips together, said low melting point element having a minimum width to maximum thickness ratio of at least 2:1 and having dimensions which are only slightly greater than the corresponding dimensions of the gap between said arcuate end portions.

4. An electric bi-metallic fuse link comprising a pair of high melting point elements in the form of strips arranged end to end, flat arcuate end portions on the adjacent ends of said strips, each of said arcuate end portions being less than a semi-circle in extent, a low melting point element of less width than the width of said strips having correspondingly curved edges connecting said strips together, said low melting point element having a minimum width to maximum thickness ratio of at least 2:1, portions of reduced cross-section in said strips, said curved edges of said low melting point element overlapping said arcuate end portions by a relatively small amount whereby said low melting point element does not remain suspended between said strips when in a molten condition.

5. An electric bi-metallic fuse link comprising a pair of high melting point elements in the form of strips arranged end to end, flat curved end portions on the adjacent ends of said strips, a low melting point element having correspondingly curved edges connecting said strips together, said low melting point element having a minimum width to maximum thickness ratio of at least 2:1, portions of reduced cross-section in said strips, said curved edges of said low melting point element overlapping said end portions by a small amount whereby to prevent suspension of said low melting point element when in a molten condition between said adjacent ends of said strips, a boric acid coating surrounding said low melting point element.

6. An electric bi-metallic fuse link comprising a pair of high melting point elements in the form of strips arranged end to end, flat curved end portions on the adjacent ends of said strips, each of said curved end portions being less than a semi-circle in extent, a low melting point element of less width than the width of said strips having correspondingly curved edges connecting said strips together, said low melting point element having a minimum width to maximum thickness ratio of at least 2:1, portions of reduced cross-section in said strips, said high melting point element comprising copper strips, and said low melting point element comprising a lead-tin alloy insert.

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