May 19, 1942. S. R. SMITH, JR 2,283,701

CIRCUIT INTERRUPTING ELEMENT

Filed Aug. 18, 1939

Fig. 1.

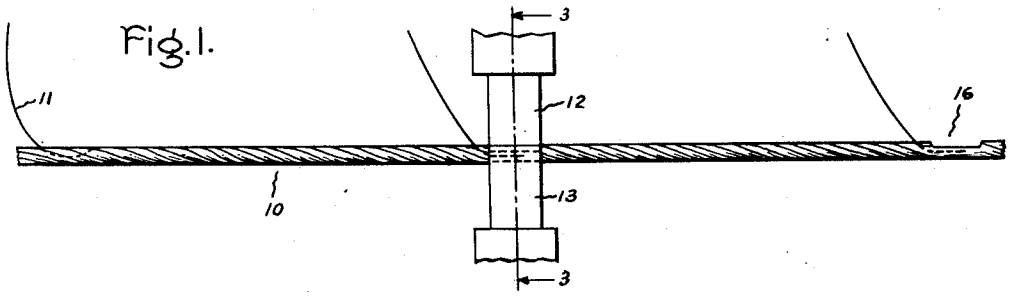


Fig. 2.

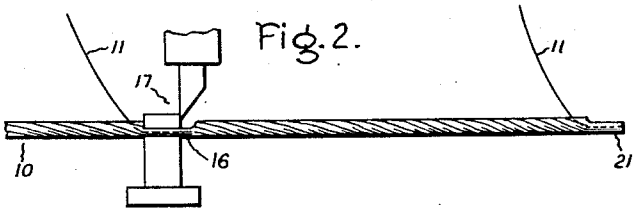


Fig. 4.

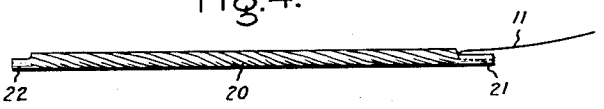


Fig. 3.

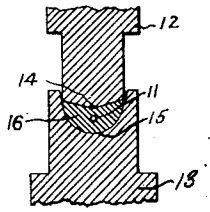


Fig. 6

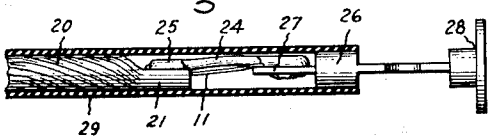
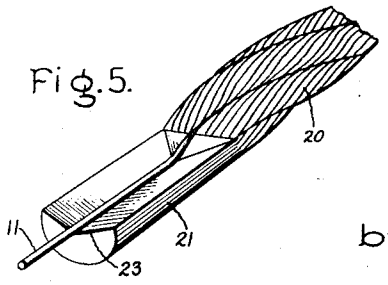


Fig. 5.



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His Attorney.

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UNITED STATES PATENT OFFICE

2,283,701

CIRCUIT INTERRUPTING ELEMENT

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Application August 18, 1939, Serial No. 290,859

9 Claims. (Cl. 200—135)

The present invention relates to circuit interrupting elements, and more particularly to circuit interrupting elements, such as fuse links or the like, having a fusible, rupturable or other form of intermediate circuit interrupting section mechanically connected between two terminal elements, at least one of which terminal elements comprises a flexible stranded connection conductor.

Among the objects of the invention is the provision, in a circuit interrupting element such as referred to above, of an improved construction for effecting a joint between the flexible stranded connection conductor and a strain element, fuse wire or the like forming part of the intermediate section. A joint formed in accordance with the present invention has, among others, the advantages of simplification of manufacture and lower cost, reduction in number and weight of parts, more effective control of conductive characteristics, increased strength to withstand mechanical strain in those installations where the circuit interrupting element is subjected to tension, and greater reliability and safety in operation of the circuit interrupting element.

The invention, as will be evident from the ensuing description, may be applicable to the manufacture of various forms of circuit interrupting elements of the general nature set forth above. However, for the purpose of conveying a full understanding of the details of that which I consider to be novel and my invention I have chosen to describe herein and illustrate in the accompanying drawing, an exemplary embodiment of the invention as incorporated in a cable-type tension fuse link, it being intended that the scope of the invention be determined by the appended claims.

In the drawing, Figs. 1 and 2 illustrate successive steps in the manufacture of a connection conductor for the practice of the present invention; Fig. 3 is an enlarged detail view of a section along the line 3—3 of Fig. 1; Fig. 4 shows a connection conductor ready for assembly in a fuse link; Fig. 5 is an enlarged detail perspective view of one end of the conductor of Fig. 4, and Fig. 6 is a partial view of an exemplary form of fuse link embodying the present invention.

Referring to the drawing, 10 designates a length of flexible stranded copper cable, preferably tinned, into the strands of which are inserted at regularly spaced intervals, the ends of short pieces of high strength wire 11. The length of cable 10 is only a part of a longer length of cable utilized in a continuous process of manufacturing fuse link connection conductors. The spaced parts of the cable, which have wires 11 inserted therein, are placed successively between welding electrodes such as partially shown and designated 12 and 13 respectively on the drawing. The upper electrode 12 has a wide-angle, V-shaped nose 14, while the lower electrode 13 has a cooperating semi-cylindrical seat 15. Electric current and pressure are applied to the electrodes so as to cause a welding or coalescing of the strands of that part of the cable and wire 11 which is between the electrodes. The electrodes act as forming dies and compact the part of the cable between the electrodes into the special cross-sectional shape shown in the detail sectional view of Fig. 3 and which is considerably smaller than the normal cross-sectional area of the cable. When the electric current is turned off and the compressed part of the cable allowed to cool, followed by release of the cable from the electrodes, there remains a consolidated section wherein the wire strands of the cable and the end of the corresponding wire 11 inserted therein are united into a substantially homogeneous, compact, solid and rigid mass. In those cases where tinned cable is employed, the thin tin coating of the strands forms an integral part of this mass and enters into the uniting action. Whether all or only a part of the metal of the strands is caused to fuse and coalesce in effecting consolidation of the strands and union of wire 11 therewith, depends upon the degree to which the welding operation is carried out, and this is governed by experience in determining the particular degree of welding necessary to provide a consolidation having the proper strength and other characteristics required under particular conditions. An important advantage of the process above described and the consolidated section formed thereby, is that the fused metal of the strands and the wire 11 inserted therein, acts as the sole uniting agent. Thus, no additional bonding material, such as solder, is employed, so that the weight of the consolidated section is kept at a minimum.

After formation of a consolidated section, indicated at 16 in Fig. 1, the section then is passed to a suitable cutting mechanism, indicated at 17 in Fig. 2, and the cable is severed at a point intermediate the ends of the consolidated section. The cutting off operation provides a connection conductor 20, as shown in Fig. 4, having a consolidated terminal portion 21 at one end thereof and a consolidated terminal portion 22 at the other end thereof. The presence of the

consolidated portion at each end of the connection conductor insures against subsequent "brooming" or unraveling of the strands of the conductor.

It is to be noted that the initial insertion of the end of the wire 11 between the strands of cable 10 is effected in such manner that the free portion of wire 11 will extend out of the consolidated section in a direction generally away from the cutting off point, as indicated in Fig. 2. Subsequent to the cutting off operation, the free portion of wire 11 is looped over so that it extends generally parallel with the portion of the wire which is embedded in consolidated terminal portion 21, as shown in Fig. 4. The resultant hairpin-like loop greatly increases the strength of the joint and insures against the wire pulling out of the terminal portion 21 when the fuse link, of which conductor 20 and wire 11 form a part, is subjected to tension.

In the final assembly of the fuse link, the free portion of wire 11 is pressed down, as indicated in Fig. 5, into the longitudinal groove 23 formed in terminal portion 21 by the original welding and shaping operation of electrodes 12 and 13. One end of a fuse wire 24 also is laid in groove 23 and, together with the portion of wire 11 lying in the groove, is fastened by means of a small body of solder, as indicated at 25. Due to the originally reduced section of the terminal, the body of solder may be applied without forming a projection extending beyond the surface of the flexible conductor. Thus the maximum cross-sectional dimension of the joint is kept somewhat less or at least substantially no greater than the diameter of the conductor. The other end of fuse wire 24, and the free end of wire 11, then are secured to a suitable form of terminal element, such as the one which is designated 26 in Fig. 6 and which has a fastening projection 27 and a buttonhead cap 28. The securing of fuse wire 24 and wire 11 to terminal element 26 may be accomplished in any suitable manner, such as for example that disclosed in U. S. Patent 1,992,030, to B. R. Hermann, issued February 19, 1935, which patent is assigned to the same assignee as the present invention. As is common practice, the fusible section, comprised of fuse wire 24 and wire 11, is enclosed in a relatively tight fitting tube 29 of insulation.

When the fuse link, shown in part in Fig. 6, is installed in an expulsion tube of an electric cutout in the usual manner, and the free end 22 of connection conductor 20 is connected with a fuse link terminal and tensioning means, wire 11 serves as a strain element to relieve fuse wire 24 of any mechanical strain due to tensioning of the fuse link. The effectiveness of wire 11 as a strain element is insured by the improved construction hereinbefore described, in that there is no danger of loosening or breaking of the joint between wire 11 and the terminal portion 21 of conductor 20. This joint is very rugged and is unaffected by atmospheric conditions so that it will not deteriorate. Thus, reliability of operation of the fuse link is assured.

An important advantage arising from the present invention is that no additional parts are required for the construction of the terminal portion 21 of conductor 20 and the joint between this terminal portion and the elements of the fusible section. Thus, only a relatively few manufacturing operations are required, and the size and weight of the terminal portion and joint are kept to a minimum corresponding to the cable size absolutely necessary to meet the current carrying and temperature rise requirements. The light weight and absence of additional parts also increase the safety of operation of the fuse link in that, upon ejection of conductor 20 at a high rate of speed from the expulsion tube upon fuse operation, there are no parts which might be whipped off of the conductor at such velocity and in such manner as to strike and injure anyone near by. Moreover, the consolidated form of terminal portion 21 insures against any "brooming" or expansion of the terminal portion such as would prevent ejection of the conductor from the expulsion tube. My improved terminal and joint construction has also the advantage that it makes possible a close control of the characteristics of the joint so that a very uniform resistance of the terminal may be secured.

From the foregoing it will be evident to one skilled in the art that the present invention is not limited strictly to the particular details of the exemplary form of fuse link illustrated. For example, it may be desirable in the manufacture of fuse links for certain ratings to employ only a single wire as the fusible section, or to employ other forms of strain elements. Hence, it is intended that such other modifications or applications of the invention as come within the true spirit of the invention, shall be covered by the appended claims.

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

1. A circuit interrupting element including a first terminal means, a second terminal means comprising a flexible stranded connection conductor having a terminal consisting solely of a portion of the conductor, itself, the wire strands of which portion of the conductor are consolidated into a compact solid mass wherein the wire strands are integrally united by at least a part of the metal of the strands themselves, the compact consolidated condition of said portion of the conductor being permanent and maintained solely by the integral union between the wire strands of said conductor portion, and an intermediate circuit interrupting section joined at one end to said first terminal means and joined at the other end directly to said conductor terminal.

2. In a fuse link, terminal means including a flexible stranded connection conductor having the wire strands of a part thereof consolidated and integrally united by fused metal of the strands themselves so as to form a solid and rigid terminal of reduced cross section, and a fusible section joined directly to said conductor terminal, the maximum cross-sectional dimension of the joint being substantially no greater than the diameter of said conductor.

3. A circuit interrupting element including a terminal means, a flexible stranded connection conductor having the wire strands of a part thereof consolidated into a substantially solid mass providing a terminal portion wherein the wire strands are integrally united by at least a part of the metal of the strands themselves, and an intermediate circuit interrupting section mechanically connected between said terminal means and said conductor terminal portion, which section includes an element directly joined to said terminal portion by solid embedment of at least a portion of said element in said mass, the maximum cross-sectional dimension of the

joint being substantially no greater than the diameter of said conductor.

4. In a fuse link having a rupturable section, terminal means for said section including a flexible connection conductor comprised of a plurality of strands of wire, the wire strands of a part of which conductor are consolidated and integrally united by heat and pressure with at least a portion of an element of said rupturable section solidly embedded in the consolidated part of the conductor so as to effect a solid junction between the conductor and said element having a maximum cross-sectional dimension substantially no greater than the diameter of said conductor.

5. A circuit interrupting element including a terminal means, a flexible stranded connection conductor having the wire strands of a part thereof consolidated and welded into a solid mass providing a terminal, and an intermediate circuit interrupting section mechanically connected between said terminal means and said conductor and including a wire-like element having a looped portion directly joined to said conductor terminal, the maximum cross-sectional dimension of the joint being substantially no greater than the diameter of said conductor.

6. A fuse link including a flexible stranded connection conductor having the wire strands of a part thereof consolidated and welded into a solid mass wherein the wire strands are integrally united by at least a part of the metal of the strands themselves, and a rupturable section including a wire-like element having a looped portion, at least a part of which looped portion is solidly embedded in said mass, the maximum cross-sectional dimension of said mass being substantially no greater than the diameter of said conductor.

7. A fuse link including a terminal element, a flexible stranded connection conductor having the wire strands of a part thereof consolidated and welded into a solid mass providing a terminal of a cross section substantially smaller than that of said conductor, a fuse wire connected between said terminal element and said conductor terminal, and a strain element connected at one end to said terminal element and having a portion of the other end thereof solidly embedded in said mass.

8. A circuit interrupting element including a terminal means, a flexible stranded connection conductor having the wire strands at one end thereof consolidated into a substantially solid and rigid terminal body having a longitudinally extending groove, and an intermediate circuit interrupting section interconnected between said terminal means and said terminal body and including a wire-like element having a looped portion, a pair of which looped portion is solidly embedded in said body and another part of which looped portion lies in said groove.

9. A fuse link comprising a terminal element, a flexible stranded connection conductor having the component wire strands at one end thereof consolidated into a substantially solid and rigid terminal body having a longitudinally extending groove, and a rupturable section connected between said body and said terminal element and including a wire-like strain element having a portion extending substantially longitudinally of and solidly embedded in said body, said strain element having another portion lying in said groove and extending substantially parallel to said first mentioned portion of the strain element.

SIDNEY R. SMITH, JR.