March 7, 1944. J. M. WALLACE 2,343,723

CIRCUIT INTERRUPTER

Filed Sept. 9, 1939 2 Sheets-Sheet 1

Fig. 1.

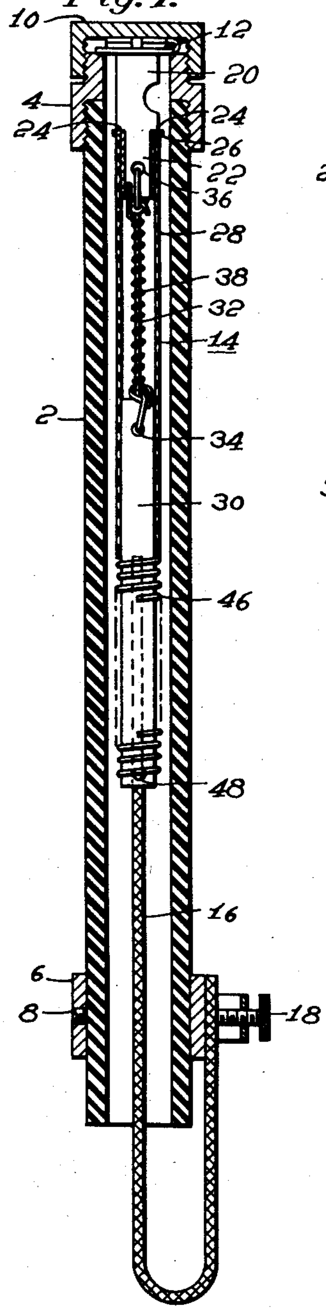


Fig. 2.

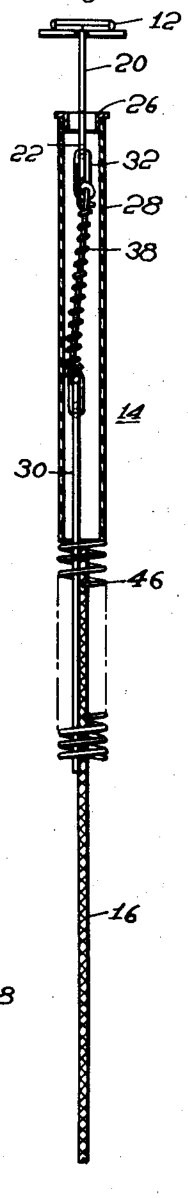


Fig. 3.

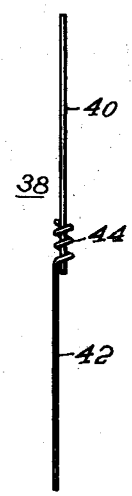
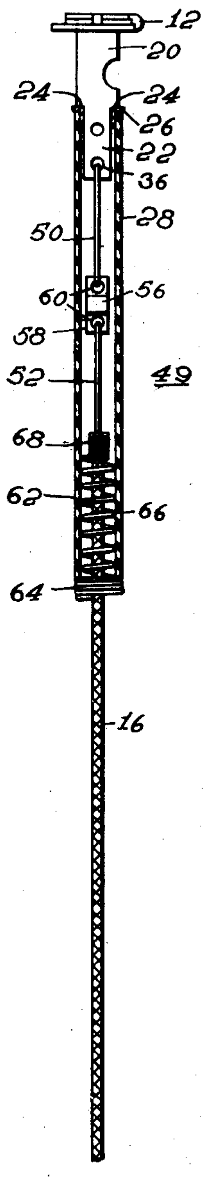


Fig. 4.



WITNESSES:

Edward Michaels

A. T. Stratton

INVENTOR

James M. Wallace.

BY

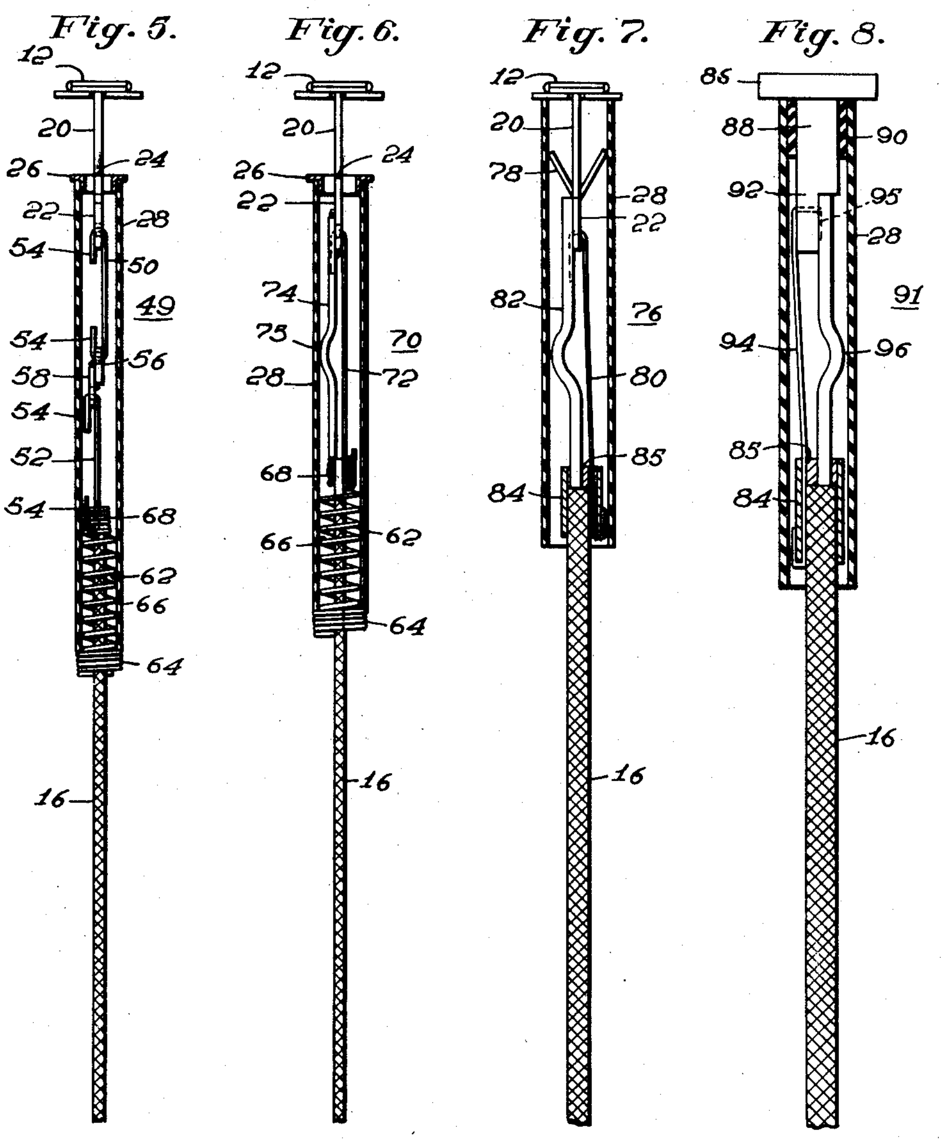
Ralph H Swingle

ATTORNEY

March 7, 1944. J. M. WALLACE 2,343,723

CIRCUIT INTERRUPTER

Filed Sept. 9, 1939 2 Sheets-Sheet 2



WITNESSES:

Edward Michaels

A. T. Stratton

INVENTOR

James M. Wallace.

BY

Ralph H. Swingle

ATTORNEY

Patented Mar. 7, 1944 **2,343,723**

UNITED STATES PATENT OFFICE

2,343,723

CIRCUIT INTERRUPTER

James M. Wallace, North Braddock, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application September 9, 1939, Serial No. 294,073

12 Claims. (Cl. 200—135)

My invention relates generally to circuit interrupting devices, and more specifically to fuse links adapted to be mounted in standard fuse holders, and circuit interrupter constructions for quickly separating interrupted portions of a circuit.

Great difficulty has been encountered with fuse links because of their relatively low mechanical strength. At least the fusible portion of a fuse link is usually made of a material having a relatively low tensile strength, and when this is utilized as a fuse link, particularly for low current ratings, its cross sectional area must necessarily be small, resulting in an undesirably low mechanical strength. This is especially undesirable where it is desired to pre-tension the link to obtain a quick separation of the fused portions of a link, to draw out and extinguish the resulting arc.

Many rather complex schemes have been proposed for increasing the mechanical strength of fuse links, and one object of my invention is to provide a relatively simply fuse link construction which is of a high mechanical strength.

In the protection of high voltage circuits where relatively low currents are to be interrupted, it is highly desirable to provide a fuse which is not only capable of giving protection against heavy overloads, such as short circuits, but to also give protection against relatively light overloads, which may become harmful because of their continued duration. Thus, apparatus served by a circuit may be capable of withstanding light overloads for a short period of time without being damaged, as by excessive heating, but such overloads, if continued, may cause considerable damage.

Accordingly, another object of my invention is to provide a novel fuse of simplified form which will give protection both for heavy overloads, and light continuing overloads.

Another object of my invention is to provide a novel fuse of simplified form, which will open a circuit substantially instantaneously on heavy overloads and short circuits, and which will operate with a time lag on relatively light continuing overloads.

Fuse links are often supported in tubular enclosures having inner walls of a material capable of evolving an arc extinguishing gas when in proximity to an electric arc, and in order to obtain liberation of larger amounts of such a gas, and at the same time to increase the arc voltage, I have provided a fuse link with means for separating the fused portions thereof and to coincidentally draw out the arc formed, into contact with a larger portion of the gas evolving material.

Hence, it is another object of my invention to provide novel and simplified means for quickly separating the fused parts of a fusible link to draw out and extinguish the resulting arc.

A further object of my invention is to provide a fuse link of improved form adapted for insertion in a standard fuse holder.

A still further object of my invention, is to provide a novel fuse of a practical design, which is of relatively simple construction, and susceptible of easy and economical manufacture.

These and other objects of my invention will become more apparent, upon consideration of the following specification, and attached drawings, in which:

Figure 1 is a vertical sectional view of a fuse holder showing one of my improved refill units in operative position therein;

Fig. 2 is a vertical sectional view of the refill unit shown in Figure 1 taken at right angles to Fig. 1;

Fig. 3 is a partial view of the fusible element of Figures 1 and 2;

Fig. 4 is a vertical sectional view of a modified form of fuse refill;

Fig. 5 is a vertical sectional view of the refill shown in Figure 4 but taken at right angles to the position shown in Figure 4;

Fig. 6 is a vertical sectional view of another modified form of refill;

Fig. 7 is a vertical sectional view of a still further modified form of refill; and

Fig. 8 is a vertical sectional view of another slightly modified form of refill.

In the embodiment of my invention shown in Figures 1 to 3, I have shown a fuse holder which includes the elongated insulating tube **2** of any desired insulating material such, for example, as fiber, having a terminal ferrule **4** threadedly engaged with the upper end thereof, and a lower terminal collar **6** around the outside of the insulating tube adjacent the lower end thereof, and secured in position on the tube by the set screw **8**. An upper terminal cap **10** is threadedly engaged with an extension of the terminal ferrule **4**, for clamping an upper fuse refill terminal head **12** between the inner wall of the cap **10** and the upper terminal ferrule **4**. The upper terminal head **12** forms the upper terminal for the fuse refill **14**. The lower terminal of the refill **14** includes a flexible lead **16** shown depending from the lower end of the refill and extending out of the lower end of the fuse tube 2 and having its outer end connected to the lower terminal collar 6, as by the set screw 18 having a knurled head. The refill upper terminal head 12, has a depending integral flat terminal portion 20 with a reduced lower portion 22 forming shoulders 24 between the two portions. A flanged collar 26 is telescoped over the lower terminal portion, and engages the shoulders 24 to form an abutment for the upper end of the fuse refill tube 28, which is also made of any desired insulating material, preferably fiber or the like. The refill includes a lower flat terminal portion 30, having its upper end extending into the refill tube 28, and being apertured as at 34. A strain element 32 has its ends extending through the aperture 34 in the lower terminal member, and aperture 36 in the upper terminal member, respectively, and is secured thereto, as by tying the ends. The strain member 32 is of a combustible organic material, such, for example, as a cotton string. A fuse wire 38 has its ends secured to the two refill terminals by any suitable means such, for example, as by soldering, and as shown in Fig. 3, the fuse wire 38 includes two separate parts 40 and 42 connected to the refill terminals, respectively. The lower fuse portion 42 has its upper end coiled about the lower end of the upper fuse portion 40 to form a sliding and conducting connection 44. This connection is normally secured against movement by a low melting point solder, such for example, as a lead-bismuth alloy. The two refill terminals 20 and 30 are formed of suitable conducting material such, for example, as tinned copper strip, fuse wire 38 is preferably formed of suitable resistance material such, for example, as a copper nickel alloy, and flexible lead 16 is preferably formed of a plurality of small copper wires twisted together. A coil spring 46 surrounds the lower terminal 30 where it projects from the refill tube 28, and it is held in compressed condition, by abutting at its upper end against the lower end of the refill tube 28, and by having its lower end inserted in an aperture 48 in the lower terminal member 30. The spring thus maintains the fuse assembly under tension, the tension being taken by the strain element 32. The fuse assembly, which includes the strain element 32 and the fuse element 38, coiled around the strain element, is preferably coated with a thick high resistance, weatherproof coating, such as a material known as a shellac-dag composed of a clear neutral shellac and lamp black to exclude moisture and other contaminations in the surrounding atmosphere from deteriorating the strain element 32. This coating also has another purpose to be hereinafter described.

In the operation of this embodiment of my invention, if a small overload appears in the circuit, the fuse wire 38 becomes warm and melts the soldered joint 44. Due to the peculiar construction of this joint and due to the fact that there is no strain on the fuse wire, this joint continues to conduct current just as though it were cold. The heated wire, however, causes the strain element 32 to deteriorate until it becomes weak enough for the spring 46 to break it. The fuse wire then pulls apart at the soldered joint 44, under the influence of the spring 46, and the spring ejects the terminal 30 from the refill tube 28, out the lower end thereof, thereby drawing out the arc formed by separation of the fuse wire into engagement with the walls of the refill tube 28 and the fuse tube 2. Inasmuch as it is well known that fiber insulation is capable of evolving a relatively large quantity of arc extinguishing gas, when in proximity with an electric arc; the subsequent gas blast produced by the arc playing on the tube walls causes interruption of the circuit and extinction of the arc. On high current overloads, such as short-circuits, the fuse wire and strain element are destroyed immediately and interruption takes place in the same manner described above. It is possible for the wire to be completely destroyed by a high current surge due to switching or lightning. If this were to occur, at an opportune time in the alternating current voltage cycle, it would be possible for circuit interruption to take place without a power arc. This would leave the strain element 32 intact, and prevent the fuse from indicating that interruption had taken place. This defect is overcome by a second means of heating the strain element, namely, the protective coating of shellac-dag. This coating being of very high resistance, in the range between 20,000 and 200,000 ohms, it normally conducts no current, but when the fuse wire is destroyed, line voltage appears across it, and the voltage gradient is high enough to flash over the surface of the shellac and lamp black coating and produce enough heat to sever the strain element. From there on, the operation is as before. It is apparent that when interruption occurs, the spring will eject the lower refill terminal 30 from the refill tube 28 so that the lower flexible conductor 16 will be ejected from the fuse holder 2 and extend a substantial distance therebelow and the refill terminal 30 itself, may be expelled from the lower end of the tube 2 by the action of the spring 46 and the gas blast expulsion action. In either event a visual indication of the condition of the fuse is afforded.

In Figures 4 and 5, I have shown a slightly modified form of fuse refill having some parts in common with the embodiment shown in Figures 1 to 3, and such like parts will be designated by like reference numerals. The refill 49 of this embodiment includes a refill insulating tube 28 and upper terminal portion 20 of conducting material having a top terminal head 12 adapted to be clamped in a fuse holder such as that shown in Figure 1. The upper terminal 20 likewise includes a lower reduced portion 22 forming shoulders 24 for the reception of an abutment collar 26, for the upper end of the insulating refill tube 28. The fuse assembly of this embodiment includes a pair of resistance strain wires 50 and 52 having hooked ends 54. These wires are preferably formed of a suitable resistance alloy such, for example, the nickel chromium alloy known as "Nichrome." The upper resistance element 50 has its upper hooked end engaged in an aperture 36 in the upper terminal 20, and has its lower hooked end engaged in an aperture 60 of a flat conducting piece 56, of any suitable conducting material such, for example, as a tinned copper strip. A similar conducting piece 58, has an aperture 60 engaging the upper hooked end 54 of the lower resistance element 52, and the two conducting pieces 56 and 58, have substantial portions of their end adjacent faces secured together, as by a low melting point alloy, thus forming a slip connection between the two resistance elements 50 and 52. Heretofore, it has been the practice to solder the two resistance elements together or to solder the two resistance elements together inside a small tube at the center thereof. A much stronger construction is formed when the resistance elements are hooked, and then soldered through the apertures in the refill terminals and the conducting strips 56 and 58, as shown in Figures 4 and 5. It can be seen that a very large area soldered joint is formed by the conducting pieces 56 and 58, which will carry a mechanical load at least as great as the resistance wires themselves. The lower end of the lower resistance element 52 is anchored to a coil spring 62 which tensions the fuse assembly. The spring 62 has three different portions. Thus, it has an enlarged portion 64 of a size to engage the lower end of the refill insulating tube 28, an intermediate portion of reduced diameter 66 slightly smaller than the internal diameter of the refill tube 28, and an upper end collar portion 68 of still smaller diameter, which forms a collar about the upper end of the flexible lead 16. The lower end of the resistance element 52 has its hooked portion 54, engaging through the collar portion 68 of the spring 62, and the flexible terminal 16 is secured within the collar portion 68 as by soldering.

The operation of this form of my invention is much the same as the first embodiment described. Upon the occurrence of light overloads in the circuit which continue for a sufficient length of time, the resistance wires 50 and 52 become heated, and in turn heat the soldered connection between the conducting pieces 56 and 58. If this heating is continued for a sufficient length of time, the solder will soften and the spring 62 which is held under tension will operate to separate the conducting pieces 56 and 58, and draw the same out toward the lower end of the refill tube. Upon the occurrence of heavier overloads or a short-circuit, the resistance elements 50 and 52 will be immediately destroyed and the spring 62 will operate to separate the opened circuit, as before.

In the embodiment of my invention shown in Figure 6, I have shown a fuse refill 70 having a spring assembly much like that shown in the embodiment of Figs. 4 and 5. Hence, like reference characters will be used here to identify like parts. This embodiment of my invention differs from that shown in Figs. 4 and 5, in that but a single strain wire 72 is employed. The strain wire 72 has hooked ends for engaging the upper refill terminal 20 and the upper coils 68 of the spring 62. The strain wire 72 may be formed of any desired resistance material, and in this embodiment of my invention is formed, for example, of steel or the like. A fuse link 74 is secured to the upper refill terminal 20 and the spring collar 68 by being soldered thereto, and includes a central outwardly bent portion 75 to insure that the strain be taken by the strain element 72. The fusible element may be made of any desired fusible material such, for example, as a lead alloy.

In the operation of this form of my invention, upon the occurrence of a predetermined overload circuit, the fusible element 74 melts, whereupon current flows through the strain element 72 which, being of a relatively high resistance, is vaporized, and the spring 62 then separates the opened portions of the circuit within the fuse refill tube in the same manner described in connection with the previous embodiments.

In Figs. 7 and 8. I have shown fuse refill elements 76 and 91 adapted for higher current ratings than those heretofore described, and hence these species of my invention do not include a stressed spring for separating the fused portions of the refill. In the embodiment shown in Fig. 7, I have shown an upper fuse terminal 20 having the terminal head 12 as in the previous embodiments. In this embodiment, however, the insulating refill tube 28 engages directly with the terminal head 12, and a locking member 78 is disposed through an aperture in the upper terminal 20 and bent when assembled to engage the inner wall of the fuse refill tube 28. The locking wire 78 is preferably made of a resilient material such, for example, as a phosphor-bronze alloy. A strain wire 80 has its upper end hooked through an aperture in the upper terminal 20, as in the previous embodiments, but it has its lower end hooked over the lower edge of a conducting collar 84 provided over the upper end of the flexible lead 16. The collar 84 is formed of any suitable conducting material such, for example, as copper tubing. The collar 84 projects above the upper end of the flexible lead 16 to receive the lower end of the fusible link 82, made of any desired fusible material such, for example, as tin. The fuse link is secured in the upper end of the collar 84 by solder 85. The upper end of the fuse link is secured to the upper refill terminal 20 in any desired manner such, for example, as by solder.

The operation of this form of my invention is substantially the same as that of Fig. 6, except that instead of employing a spring for separating the fuse portions of the refill, the weight of the flexible lead 16, collar 84, and the parts associated therewith, as well as the expulsion action of the gas blast produced by the arc playing on the inner walls of the fiber refill tube, are relied upon to expel the lead 16 from the lower end of the tube.

The embodiment of my invention shown in Fig. 8 is much like that shown in Fig. 7, and like reference numerals will be used to identify like parts. This fuse refill is also intended for high current rating, and includes the upper terminal head 86, having a depending refill terminal 88 provided with a reduced lower end 92, which is apertured for the reception of the hooked upper end of the strain element 94, and to one face of which the fuse link 96 is soldered as at 95. The strain wire 94 and the fuse link 96 have their lower ends connected to the flexible lead 16 in the same manner as in the embodiment shown in Fig. 7. The insulating refill tube 28 also engages the upper terminal head 86 directly as in the embodiment shown in Fig. 7, but here an insulating bushing 90 is provided between the upper end of the fuse tube, and the upper terminal, to properly center and support the insulating tube 28.

The operation of this embodiment of my invention is the same as for the embodiment shown in Fig. 7 and hence will not be repeated.

It will be noted that in the embodiments shown in Figs. 4 to 8, preformed strain elements are used throughout. These preformed elements being machine made, will insure a constant length of fuse element from one link to another of the same rating, thus improving the consistency of blowing characteristics. They will also reduce assembly time because there is no further necessity for measurement of element length upon assembly. High mechanical strength is obtained for the refill links by hooking the strain elements through apertures in the refill terminals, and through collars in the embodiments shown in Figs. 4 to 8, before soldering. In the embodiments shown in Figs. 7 and 8, the copper tube 84 may be crimped on to the flexible lead 16 before soldering, so that even if the link is heated to the softening point of the solder, the flexible lead 16 cannot be pulled out of the copper tube.

It is likewise apparent that in the embodiments of my invention shown in Figs. 4 to 6, a simple form of spring anchoring means is employed. The strain elements in these embodiments are hooked over the small turns on the upper end of the spring and the effect is the same as though a separate collar were soldered to the flexible lead 16. The purpose of this collar or group of small turns, is to make a large area soldered joint to take the mechanical strain under which the fuse operates, in some instances. By combining this collar with the spring, a separate operation is omitted, and due to the ability of the solder to flow through the turns of the spring, into the flexible lead 16, a strong solder joint is insured.

It should also be apparent that I have disclosed a fuse refill unit which is of high mechanical strength and which embodies a simplified structure providing a strong construction, and one which will operate efficiently, and which may be economically constructed. I have also disclosed simplified forms of fuses which will give protection both for heavy overloads and light continuing overloads.

Having described preferred embodiments of my invention in accordance with the patent statutes, I do not desire that my invention be limited to the particular embodiments shown and described, inasmuch as it will be obvious, particularly to persons skilled in the art, that many changes and modifications may be made in the particular embodiments disclosed, without departing from the broad spirit and scope of my invention. Therefore, I desire that my invention be given as broad an interpretation as possible, and that it be limited only by what is expressly stated in the appended claims.

I claim as my invention:

1. In a circuit interrupting device, means for automatically opening a circuit upon the passage therethrough of currents of a predetermined magnitude, a tubular enclosure therefor, a stressed coiled spring for separating the terminals of said opened circuit, and including a plurality of portions having coils of different diameters, the coils of one portion being of a size to engage an end of said enclosure, the coils of another portion being reduced in size and extending into said enclosure and the coils of still another portion being further reduced in size and closely surrounding a terminal member of said circuit opening means, the innermost coils of said terminal and enclosure engaging portions of said spring engaging said terminal and enclosure, respectively, whereby all of the coils of said terminal and enclosure engaging portions of said spring are free from stress.

2. In a circuit interrupting device, a pair of relatively infusible terminals one of which is movable, a collar, an element secured to the other of said terminals and having a hook-shaped end hooked over an edge of said collar, and said movable terminal being secured in said collar for preventing movement of said movable terminal away from the other of said terminals.

3. In a circuit interrupting device, a pair of terminals one of which is movable, an element secured to the other of said terminals and having a hook-shaped end hooked over an edge of a collar which in turn is secured to said movable terminal, said collar comprising a plurality of closely spaced turns of wire, and a fusible element also joining said terminals and having one end soldered to said collar.

4. In a circuit interrupting device, a pair of terminals one of which is movable, a collar, an element secured to the other of said terminals and having a hook-shaped end hooked over an edge of said collar which is turn is secured to said movable terminal for preventing movement of said movable terminal away from the other of said terminals, said collar comprising several coils of a stressed coil spring tending to separate said terminals.

5. In a circuit interrupting device, a pair of terminals one of which is movable, a pair of resistor elements connected to said terminals respectively, a pair of conducting elements of less resistance than said resistors and to which said resistors are connected, each of said conducting elements having a relatively large contact face, the contact faces of said conducting elements being joined by a low-melting point alloy to provide a slip connection, the area of said contacting faces being such that the joint between them will carry a mechanical load at least as great as the resistance elements, and means tensioning said movable terminal away from the other terminal.

6. A fuse refill unit, including, a first terminal having an outer terminal head portion and an inner terminal portion, an insulating tube telescoping over said inner terminal portion, a second movable terminal in the tube, fusible means in the tube connecting said terminals, and means preventing movement of said tube with respect to said first terminal.

7. A fuse refill unit, including a first apertured terminal having an abutment, an insulating tube telescoping over said terminal to engage said abutment, a second movable terminal in said tube, an anchoring collar in which said second terminal is secured, means connecting said terminals having hooked ends for engaging in said aperture and over an edge of said collar, respectively.

8. A fuse refill unit, including, a first terminal having an outer terminal head portion and an inner terminal portion, an insulating tube telescoping over said inner terminal portion, a second movable terminal in the tube, fusible means in the tube connecting said terminals, and locking means permitting insertion of said first terminal in said tube, but preventing withdrawal thereof.

9. In a circuit interrupting device, a pair of terminals one of which is movable, a collar, an element secured to the other of said terminals and having a hook-shaped end hooked over an edge of said collar, said collar comprising a plurality of closely spaced turns of resilient wire, and said movable terminal secured in said collar.

10. In a circuit interrupting device, a pair of terminals one of which is movable, a pair of low resistance conducting elements, a pair of resistor elements connected to said terminals respectively, and to said low resistance conducting elements, each of the latter having a relatively large flat contact face, the contact faces of said conducting elements being joined by a low-melting point alloy to provide a slip connection, and means tensioning said movable terminal away from the other terminal.

11. In a circuit interrupting device, a pair of terminals one of which is movable, a collar, an element secured to the other of said terminals

and having a hook-shaped end hooked over an edge of said collar, a fusible element secured at one end to the other of said terminals, said one terminal and the other end of said fusible element being received in said collar, and means securing said one terminal and fusible element in said collar.

12. In a circuit interrupting device, a pair of terminals one of which is movable, a pair of low resistance conducting elements each having a relatively large contact face, means conductively connecting said conducting elements to said terminals, respectively, said connecting means between at least one of said conducting elements and its connected terminal comprising a resistor element having a higher resistance than said conducting elements, the contact faces of said conducting elements being joined by a low-melting point alloy to provide a slip connection, the area of said contacting faces being such that the joint between them will carry a mechanical load at least as great as the resistance elements, and means tensioning said movable terminal away from the other terminal.

JAMES M. WALLACE.