

Oct. 31, 1944.

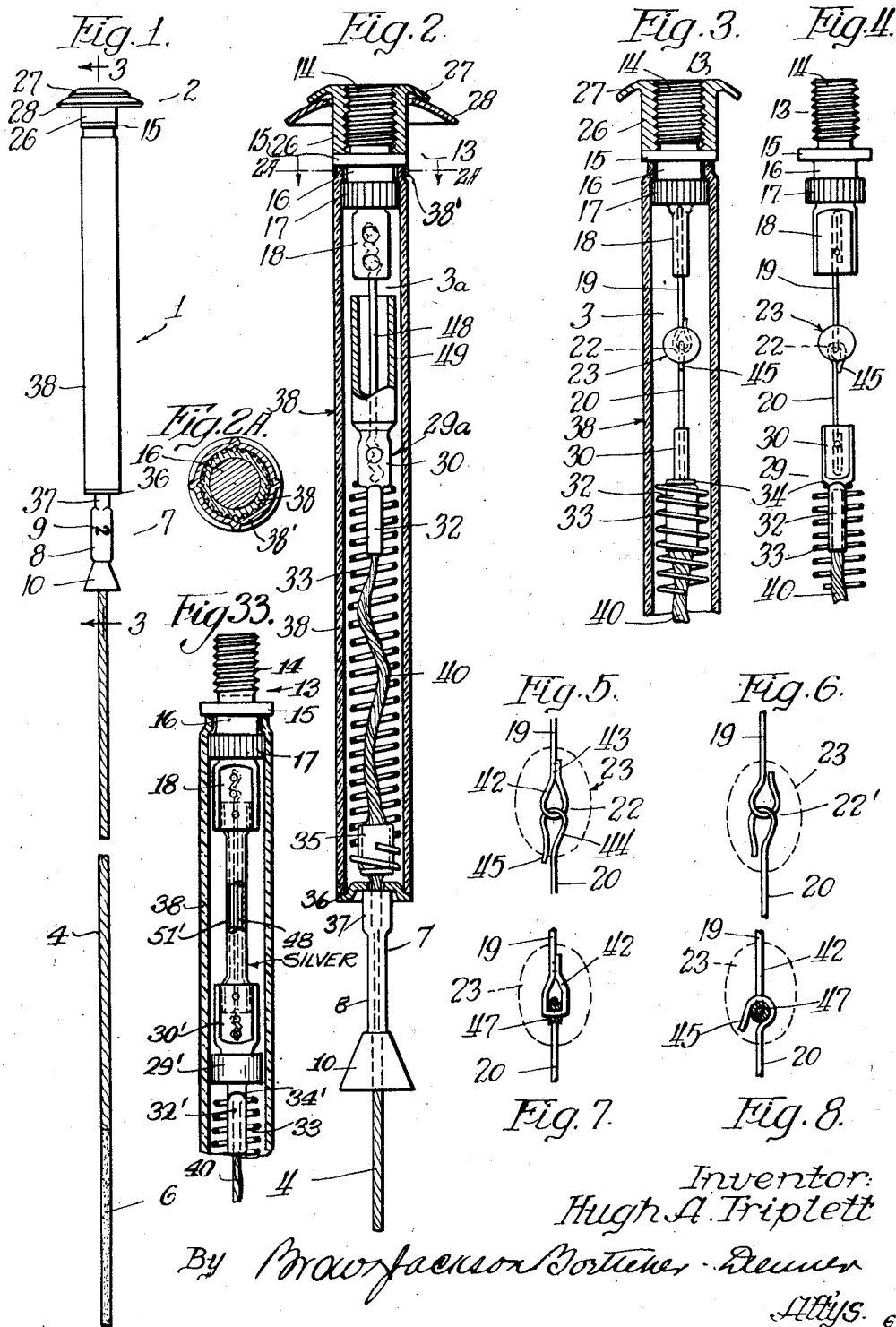
H. A. TRIPLETT

2,361,666

ELECTRICAL FUSE

Filed Dec. 20, 1934

6 Sheets-Sheet 1



Inventor:
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Oct. 31, 1944.

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2,361,666

ELECTRICAL FUSE

Filed Dec. 20, 1934

6 Sheets-Sheet 2

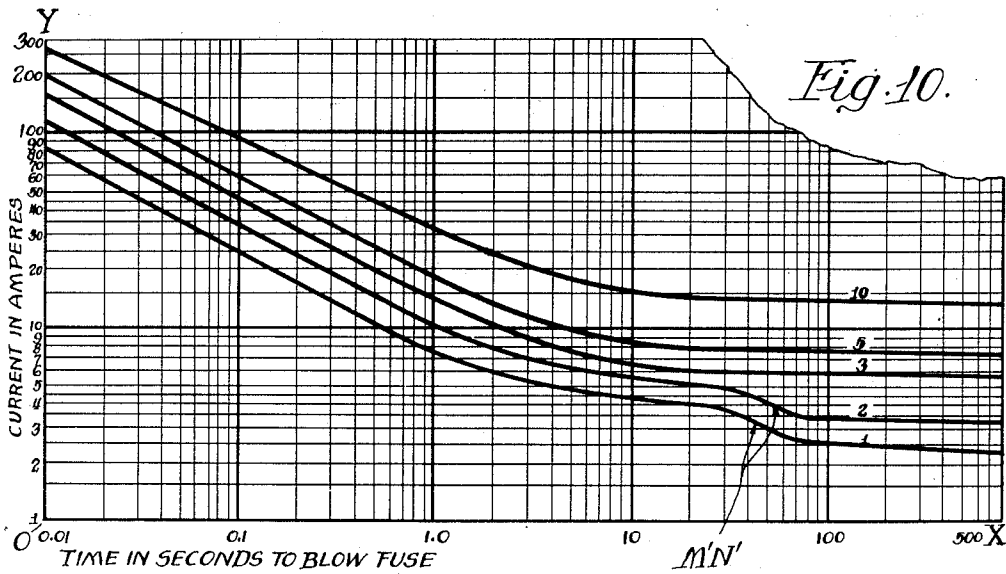


Fig. 11.

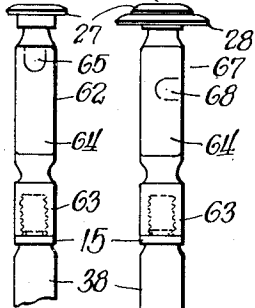


Fig. 13.

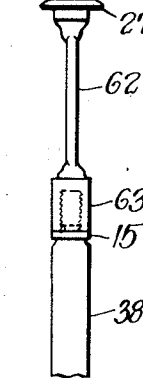


Fig. 14.

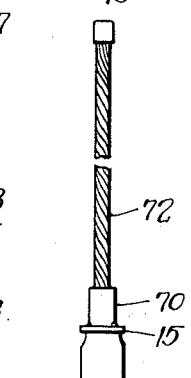


Fig. 16.

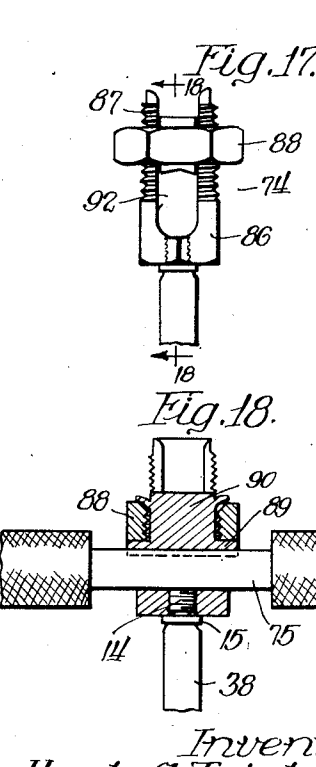


Fig. 12.

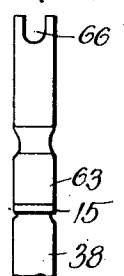


Fig. 15.

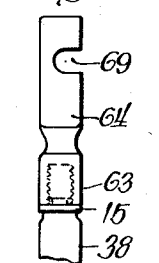


Fig. 17.

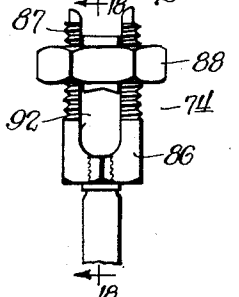
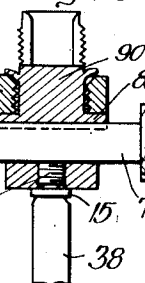


Fig. 18.



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Fig. 19.

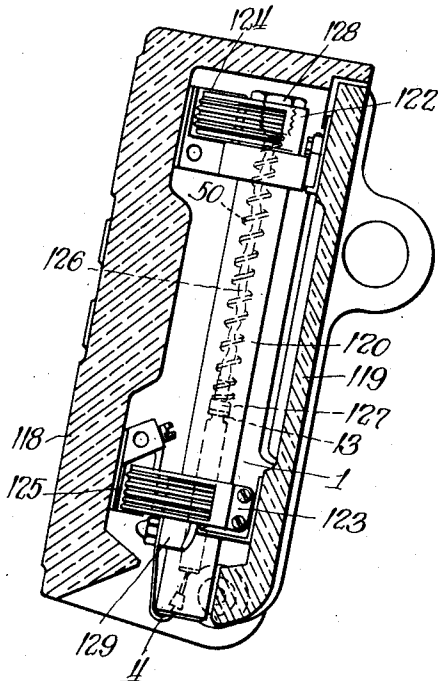


Fig. 20.

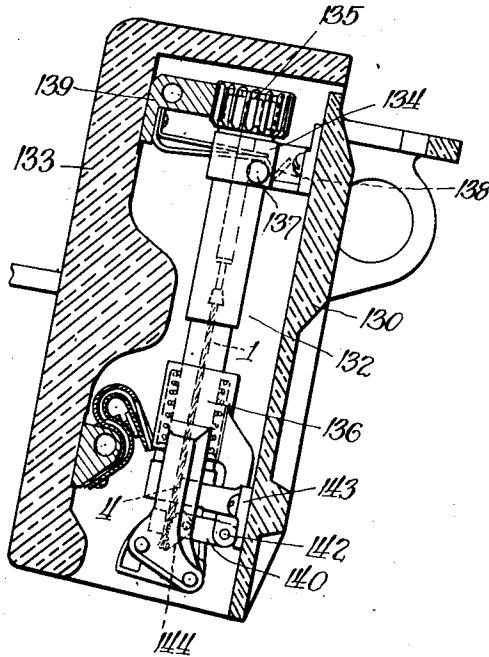
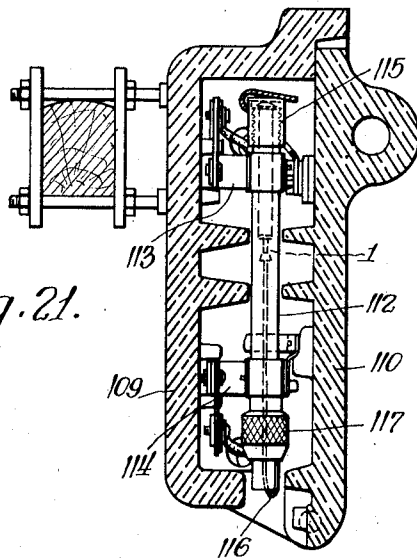


Fig. 21.



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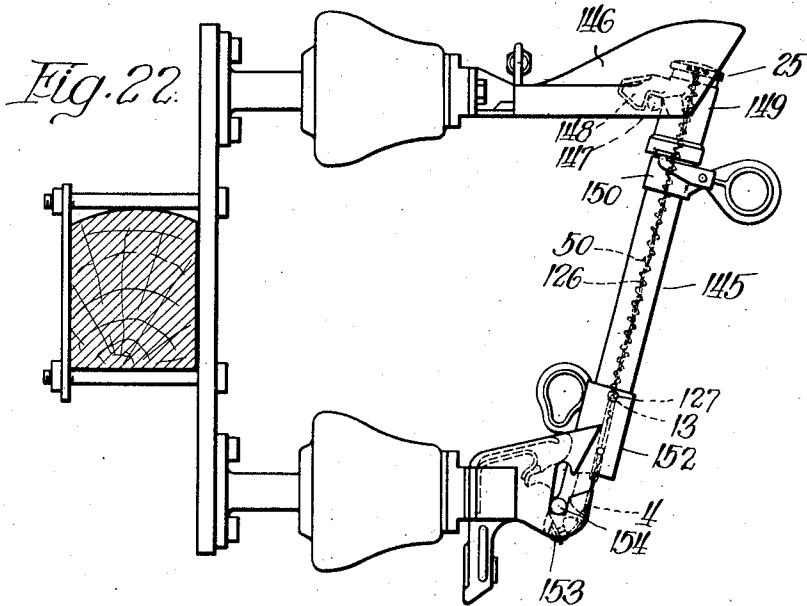
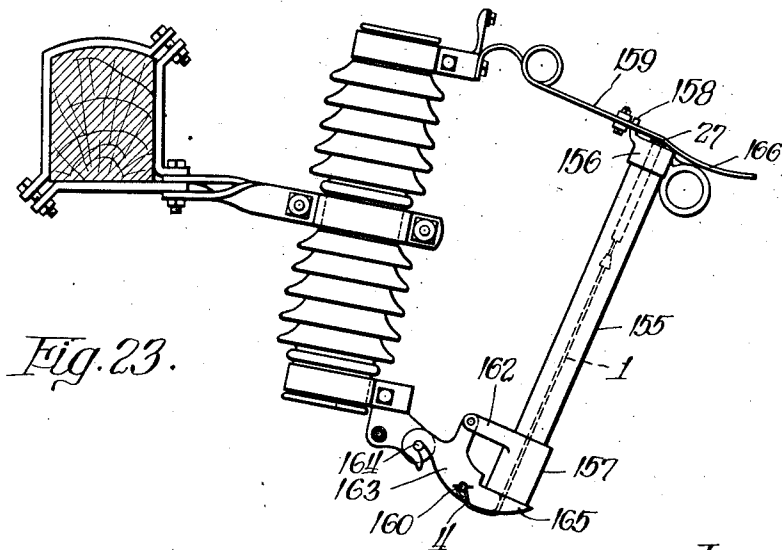
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Filed Dec. 20, 1934

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Fig. 24.

Fig. 31.

Fig. 32.

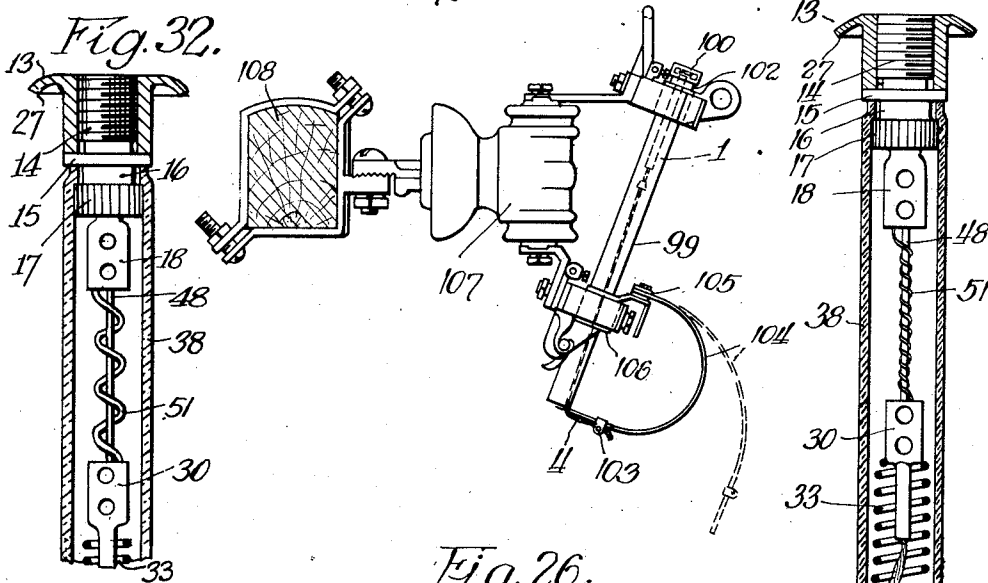


Fig. 25.

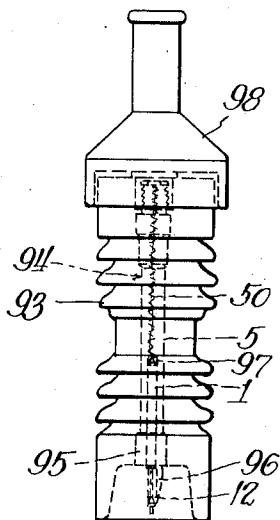
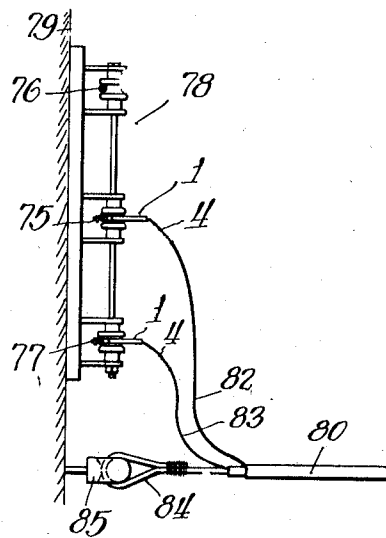
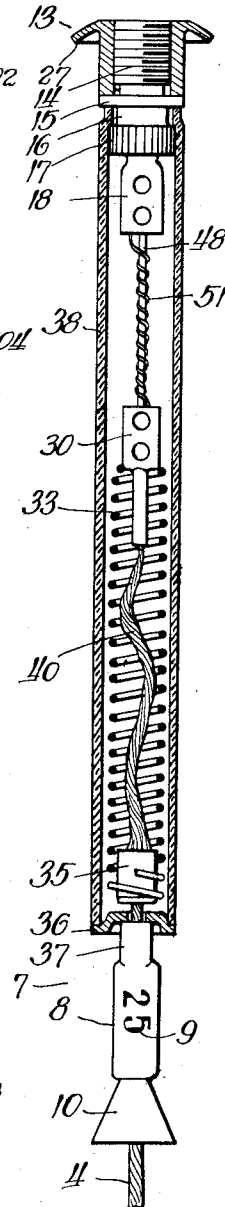


Fig. 26.



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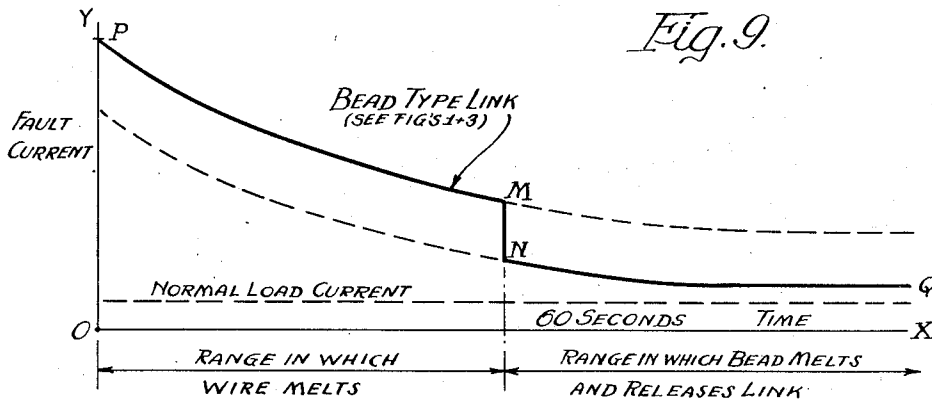
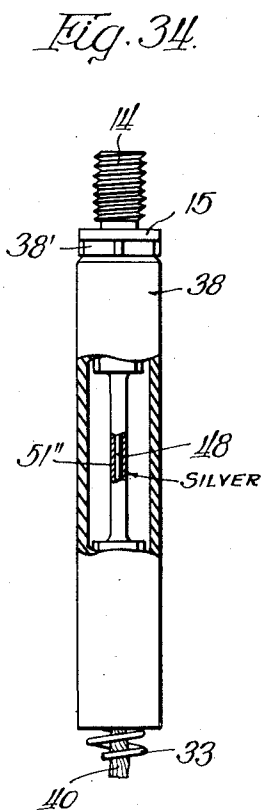
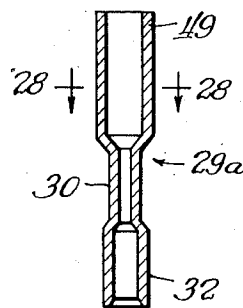
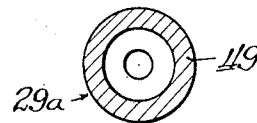
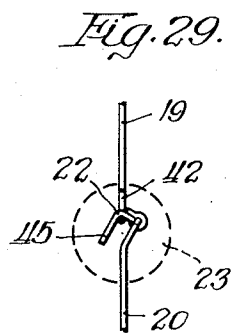
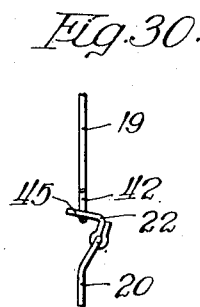


Fig. 27.



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UNITED STATES PATENT OFFICE

2,361,666

ELECTRICAL FUSE

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Application December 20, 1934, Serial No. 758,372

34 Claims. (Cl. 200—117)

My invention relates to electrical fuses.

While the preferred form herein disclosed relates to fuses of small current carrying capacity, I do not wish to limit the invention to any particular use or capacity but intend to include all phases of the invention, wherever useful.

According to present practice, distribution systems usually operating at from 5000 volts to 15,000 volts are protected by fuse devices of various construction and variously designated. Because of the large number required in a system of any extent, the item of initial expense and maintenance is a paramount consideration. The air break fuse has chiefly for this reason been widely adopted. Due to the location of these devices remote from the central station busses and with the reactance of the lines intervening, the amount of current that must be interrupted is limited to values which make air break fuses operating upon the expulsion principle fairly satisfactory. These fuses are disposed in or on various forms of mountings.

The air break fuse of the expulsion type comprises essentially a tube of insulation with a fusible link threaded therethrough. The fusing of the link upon overload is intended to create suddenly such a volume of vapors and gases as to expel the terminal or terminals from the end or ends of the tube and thereby to interrupt the circuit.

The typical commercial embodiment of the expulsion fuse early took the form of a tube of insulation with ferrules upon the ends, and a closure for one end with the fusible portion of the link disposed adjacent said closed end. Great numbers of devices of this character have been employed, and are still in commercial use.

It was early recognized by my assignee that the simple expulsion fuse, while, in general, it operated fairly satisfactorily on relatively heavy overloads, came into difficulty on low overloads, as the expulsive force was not great enough to expel the link and cause separation of the terminals, and interruption. Destruction of the device resulted. Fuses of large current carrying capacity are less subject to this particular difficulty because the blowing of a large capacity link releases enough energy to create a satisfactory expulsive effect. My present invention is particularly useful for low amperage fuses.

Another difficulty with fuses of this type has been the uncertainty as to time-current characteristics, particularly on low amperage fuses. A further uncertainty resided in the uncertain length of arcing time of fuses as heretofore constructed.

The prior United States patent to Conrad, No. 1,466,423, largely overcame these difficulties by placing the fuse link under spring tension and surrounding the fusible element with a cork. Em-

ployment of spring tension was practicable because a method of relieving the fusible element from stress and possible injury by the spring load had been satisfactorily worked out, i. e., the use of the so-called strain wire. Upon the occurrence of overload great enough to cause fusing of the fusible element, the terminals were promptly separated far enough to insure expulsive action and interruption of the current flow.

I have conceived the expulsion fuse as being, of necessity, a dual range device. According to my conception of the ideal expulsion fuse, it must have the capacity for operating in one fashion upon low overloads, and in another fashion upon high overloads, but these two modes must be so coordinated as to be mutually helpful or to overlap in producing the desired result. In brief, the two modes of operation must work in the same general direction, so that in the intermediate range when both actions occur, they may overlap and work to the common end. The device of my present invention is designed to do this.

In considering various forms of fuse devices upon the market, I have conceived the possibility of incorporating within the fuse link itself the principle of operation of the aforesaid Conrad United States Patent No. 1,466,423, so that the resultant device employing such link will have the desired plural range action and suitable time-current characteristics, short arcing time, etc.

One of the primary objects of my invention is to provide a fuse link for use in fuse holders of various forms or for various mountings to constitute the same as plural range fuse devices with suitable predeterminable time-current characteristics and arcing time for each desired capacity.

For the accomplishment of this object and other objects, I have devised a form of link, which I term a universal link, having such structural form and adaptability as to permit its utilization in substantially all forms of commercial fuse devices of the general class here under consideration.

In carrying into effect the broad concepts of my invention, I have devised numerous improvements both to the end of operating characteristics and structural refinements and simplification.

One of the objects of these improvements is to provide a fuse link containing within itself the necessary means for insuring the desired characteristics of operation, independently of the particular mounting in which it is placed.

Another object of the invention is to provide an improved form of fusible element for the link, said element having a high temperature metal which is relatively free from corrosion, and has long life, accuracy in time-current characteristics, and the ability to stand momentary surges without deterioration.

A further object of the invention is to provide

for connecting a pair of fuse terminals by composite conductor means which includes a high conductivity metal sheath, the ends of the composite conductor means being held in the fuse terminals principally by frictional engagement.

A further object is to provide a fusible element which shall be suitable for withstanding the tension required in spring-loaded or weight-loaded cutouts, such as automatic dropouts or reclosing fuses, and yet be satisfactory for use in cutouts putting no tension on the link.

Another object of the invention is to provide a link provided with terminal portions adapting it to service in all or substantially all modern designs of cutouts.

A further object is the provision of links for devices of the type hereinabove referred to with accurate time-current characteristics and suitable operating ability in the entire range of elements from one ampere to 150 amperes. The links of my present invention are particularly accurate within the range of from 1 to 10 amperes, where the greatest accuracy is desirable.

Accuracy in blowing time of fuse links would be of little or no importance if heavy short-circuit currents were possible at the points where most cutouts are installed. The fact is that on most systems, and particularly rural systems, heavy short-circuit currents are the exception rather than the rule. Therefore, this means that most cutouts sold are subjected to an interrupting duty which is out on the long time blowing end of the time-current curve. Out on the low current end of the curve, reliable accuracy in blowing time and current is essential if the company insists on good operating results. By good results, I mean that the accuracy of the fuse link is such that its blowing can be so coordinated with the circuit breaker at the head of the feeder, and so coordinated with any other fuse in sequence on the line, that when a fault occurs on the load side of the cutout, the fuse link will isolate the fault in time to prevent these other fuses or breakers from opening and thus dropping the load in adjacent territory. This requires, in a fuse link, both accuracy in time-current characteristics and reliable short arcing time. No matter how accurate the melting of the link, long and indefinite arcing time will undo the benefit of such accuracy by causing other devices in sequence to operate.

Another object of the present invention is to provide a link responsive to fault current of the order of one to three or four amperes without sacrificing either thermal capacity to withstand lightning transients or the tensile strength of the wire used as the fusible section. Whereas a simple wire fusible section would have to be of hairlike dimensions, and therefore would be mechanically weak with respect to spring tension, and entirely unsuited to be installed in a cutout employing a tensioning spring, the fuse of the present invention permits the use of a heavier wire which is entirely adequate in tensile strength. The link of the present invention will melt and part at the same overload or fault current which would melt the wire of hairlike proportions. The fuse of the present invention will, therefore, withstand the spring tension which is found in all of the cutouts of my assignee and in the cutouts of the new dropout type which are coming into the market.

In carrying out this phase of the invention I employ a pair of wires, preferably of nickel-chromium alloy, having hooked engagement with

each other. The wires are of adequate mechanical strength to resist the necessary spring tension but the hooked connection will readily yield under the spring tension which is provided by straightening out the hooked or bent parts of one or both of the wires. By the provision of a molded bead of a low melting point metal or alloy which encases or embeds the hooked engagement, the pulling apart of the hooked engagement is prevented until the bead softens sufficiently to permit the end of the hook to swing about through the body of the low melting point metal and straighten out sufficiently to pull clear of the cooperating anchorage.

A further object of this invention is to provide a fuse link which has a very sharp melting and parting point on the temperature curve, that is a link which does not soften and stretch and thus reduce in cross-section as the temperature closely approaches the definite melting point. In the present construction the bead of tin or other low melting point material either allows the hooked engagement to pull apart or it will not permit the bent portion of the hook to straighten out at all. The present fuse link, therefore, does not result in a progressive lengthening of the fusible section, as would be the case if the two wires were soldered together or otherwise connected through the body of the low melting point metal.

Another object of the invention is to provide a fuse link with a novel and distinctive form of time-current characteristic curve, as illustrated in exaggerated form in Figure 9. A fuse having such a characteristic curve, that is, with the short and medium time blowing points elevated, permits the momentary surges or transients, such as lightning induced current, to pass through the device without melting of the bead. There is, therefore, less cumulative effect of repeated surges which might otherwise cause the link to melt and part at normal load current. In that part of the curve corresponding to long time blowing there is a relatively sharp dip beyond the duration time of surges and transients. Being at the long time end of the curve, and being a substantial drop in the curve, it serves as a protection against detrimental thermal effect in the transformer to which this link is applied as a protection. It is known that long continued overload of the order of 50% or possibly 100% on the transformer results in destruction of the insulation. It is therefore desirable to have the long time end of the curve as low as possible with respect to the normal load current of the transformer while the medium and short blowing time of the curve should be higher with respect to the normal load current of the transformer. It is desirable, therefore, that these two sections of the curve be joined by a section which is as nearly vertical as it is possible to provide. This object is particularly desirable for fuses of the order of one to two ampere ratings which blow on currents ranging from one to three or four amperes.

In addition to the foregoing objects there are other and numerous objects of the present invention which will be apparent from the following detailed description and the appended claims.

Now in order to acquaint those skilled in the art with the manner of constructing and operating a device in accordance with my invention I shall describe, in connection with the accompanying drawings, several specific embodiments of the invention.

In the drawings, the same or similar reference

characters designate the same or similar parts, throughout.

Figure 1 is a side elevational view of a low amperage fuse link of the order of one to two amperes, the specific fuse link shown is a two ampere link;

Figure 2 is a longitudinal axial section through a fuse of larger amperage, for example, three to ten amperes;

Figure 2-A is a detail sectional view taken along the line 2-A—2-A of Figure 2;

Figure 3 is a vertical, longitudinal section through the fuse link of Figure 1, taken on the line 3—3;

Figure 4 is a view of the fuse link and terminals taken at right angles to the view of Figure 3;

Figure 5 is an enlarged fragmentary view showing the hooked connection between the fuse wires of the structures shown in Figures 1, 3 and 4;

Figure 6 is a view similar to Figure 5 of a modification;

Figure 7 is a similar view of another modification, showing the hooked connection in section;

Figure 8 is a section of the structure shown in Figure 7 taken at right angles to Figure 7;

Figure 9 is a diagram illustrating the type of time-current characteristic curve which is secured by the fuse of Figure 1;

Figure 10 is a time current characteristic curve showing the relation between current in amperes and time in seconds to blow fuses of the present invention plotted on a logarithmic scale;

Figure 11 is a side view of an adapter for the upper terminal end of the link of my invention;

Figure 12 is a similar view of the same, with the top broken off to provide an upwardly facing notch;

Figure 13 is a side view of another form of upper terminal fitting;

Figure 14 is an edge view of the same;

Figure 15 shows the fitting of Figure 13 with the button head broken off and a notch broken out of the side edge to provide a laterally opening notch;

Figure 16 is a side view of a form of fuse link having flexible leads at each end;

Figure 17 is a side elevational view of a clamp fitting for releasably attaching one end of the fuse link of my invention to a continuous conductor;

Figure 18 is a section taken on the line 18—18 of Figure 17, showing the fitting and link applied to a continuous conductor;

Figure 19 shows the fuse link of my invention installed in one form of commercial mounting;

Figure 20 shows the fuse link of my invention mounted in a dropout box type of mounting;

Figure 21 shows the fuse link of my invention mounted in a standard commercial form of box employing no loading upon the fuse link;

Figure 22 shows an open dropout fuse mounting in which my fuse link is utilized;

Figure 23 is another commercial form of dropout fuse mounting which places a spring and gravity load upon the fuse link, and may employ the fuse of my invention;

Figure 24 is a further commercial form of open fuse mounting in which a spring loading is externally applied;

Figure 25 shows the fuse link of my invention installed in a so-called ejector cutout;

Figure 26 shows the fuse link of my invention applied directly to secondary distribution conductors and forming a link between such conductors and a drop wire;

Figure 27 is an enlarged sectional view of the radiation shield and coupling member employed in the structure of Figure 2;

Figure 28 is a cross sectional view taken on the line 28—28 of Figure 27;

Figure 29 is a side view of a modified form of hooked connection;

Figure 30 is a similar view of the same in releasing position;

Figure 31 is a longitudinal section of a fuse of higher current carrying value; and

Figures 32, 33, and 34 are fragmentary longitudinal sectional views of modified forms of the fuse link construction.

Referring first to Figures 1, 2, 3 and 6 I have shown a fuse link 1 which necessarily involves three essentials. First, a terminal portion 2, such as is suitable for attachment to one electric terminal and support, a fusible section 3 (Fig. 3), and a flexible lead and terminal portion 4 for making connection with another electric conductor with which the link is to be connected in series. The portions 2 and 4 are preferably adjustable to meet various conditions of mounting, as I shall describe more in detail. The link is preferably enclosed in a fuse tube such as the fuse tube 5 shown in Figure 25, and as shown in the prior Conrad United States Patent, 1,818,382. The flexible lead of terminal portion 4 comprises a stranded copper or the like connector the outer end of which, as shown at 6, is tinned to hold the strands together and which is provided also with a collar member 7, this collar member 7 having an intermediate portion 8 which is pinched or flattened upon the body of the lead 4 and stamped with the ampere rating, as indicated at 9, and provided with a flared or conical wedging contact 10 for engagement in a cooperating stationary wedging contact shown in the copending application of Allan Ramsey, Serial No. 671,660, and as indicated at 12 in Figure 25.

The upper terminal 2 comprises a cylindrical stud member 13 (see Fig. 4), the outer end of which is threaded at 14. The intermediate portion comprises a flange 15 which may represent the original diameter of the stock from which the stud is cut, as by a screw machine. Adjacent the flange 15 there is a groove 16 and beneath the same a knurled portion 17. The inner end of the stud 13 comprises a tubular socket portion 18 into which is inserted the upper end of the wire 19 of the fusible link 3. The tubular portion 18 is then flattened or pinched upon the end of the wire to make good electrical and mechanical connection with said wire 19.

The threaded stud 13 is adaptable to a wide variety of situations for making connection between the link and a suitable terminal, either stationary or movable, as the case may be. For connection with a stationary mounting wherein an annular seat and a cooperating cap or clamp is employed, as indicated at reference numeral 25 in Figure 22, a flanged head 26 is provided. This flanged head comprises a tubular sleeve or shank internally threaded to cooperate with the threads 14 of the stud 13 and having its upper end flanged or flared out as indicated at 27 as by a spinning operation. Where the annular seat is of greater extent than would be suitably engaged by the flange 27, a dished washer 28 is provided, this washer being passed over the link from the opposite end and resting under the flange 27. The end of the stud 13 is substantially flush with the top of the flange 27 and pro-

vides a good clamping surface additional to the top of the conical flange 27.

The wires 19 and 20 have hooked engagement at 22, shown in detail in Figure 5. A molded bead 23 of a low melting point alloy, such, for example, as solder, is molded on the hooked engagement and embeds the ends of the wires 19 and 20 where they make engagement. The lower end of the wire 20 is folded back on itself like the upper end of the wire 19 and is disposed in a tubular fitting 29, the upper end of which provides a socket 30 which is flattened upon the end of the wire 20 to grip it mechanically and to make connection electrically. The lower end of the fitting 29, which is preferably made of a piece of copper tubing or the like, is similarly pinched or flattened upon the upper end 40 of the flexible lead 4.

This fitting 29 therefore forms a coupling or junction member between the lower end of the fusible element 3 and the lead 4. It also forms an anchorage for the tension spring 33, which has its upper coil flattened against the flat sides of the pinched socket 30 and is prevented from disengagement by the shoulders 34 of the flattened part of the socket 32, since the flattened portions of the sockets 30 and 32 are so disposed that their planes are substantially at right angles to each other.

The spring 33 has its opposite end anchored directly to the flattened collar 35 which is pinched upon the flexible lead 4. Indirectly, the spring is anchored to the cap or plate 36 through the medium of the fitting 7, which has its adjacent end 37 in engagement with the plate or cap 36.

The margins of the plate or cap 36 are so formed as to center the plate or cap upon the end of a fiber tube 38. The upper end of the tube 38 is securely bound to the upper terminal stud 13 in axial alignment therewith and rigid for both rotary or axial motion with respect thereto. This engagement is secured preferably by wetting the end of the fiber tube 38, pushing it over the knurled portion 17, and then shrinking the end into the groove under the flange 15. Such shrinkage may be facilitated by pinching.

I do not wish to be limited to this particular method of fastening these parts, as other means of securing the fiber tube in place may be provided as, for example, by shrinking a metallic band 38', Figures 2 and 2-A upon the upper end thereof, or by suitable cementing, or otherwise.

The spring 33 thereby places the link 3 under a predetermined tension which, in the present instance, is of the order of seven pounds. The link shown in Figures 1, 3, 4 and 5, has the fusible element formed as shown in Figures 3, 4 and 5, and has the spring anchorage at the lower end of the tube 38 constructed in the same manner as shown at the lower end of Figure 2.

The link shown in Figure 2 employs a fusible element 3a which is slightly different in construction from that shown in Figures 1, 3, 4 and 5, as this link is designed for carrying capacities of from 3 to 10 amperes in the specific embodiment shown.

There is a definite coordination between the minimum spring tension applied to the fusible element and the character of the said fusible element, as will now appear.

In the S. & C. cutouts of the type shown in aforesaid United States Patent 1,818,382, the ten-

sion of the spring which tends to separate the terminals of the fusible link ranges from 10 to 12 lbs. This amount of tension is necessary in view of the unavoidable mass of the terminal and cable assembly which is required to extend the rating of any particular cutout to include links of higher ampere rating, say up to 60 amperes.

Now inasmuch as the present link is designed and adapted to be inserted in cutouts of that type as well as in other forms of mountings, fuse tubes and the like, it is desirable that the fusible element be capable of withstanding spring tension of that order, that is, from 10 to 12 lbs. I have provided the hooked engagement 22 and the soft metal bead 23 as a means for permitting the employment of wires 19 and 20, which are ample in cross section and mechanical strength to withstand spring loads or other loads of from 10 to 12 lbs. The wires 19 and 20 will not fuse at from 1 to 3 or 4 amperes, which is the definite overload value at which the fuse shall open, but the hooked engagement, combined with the minimum spring tension, is designed to do this under the control of melting of the molded metal bead 23. That is to say, the wires 19 and 20 must maintain good mechanical strength throughout the life of the device and must maintain substantially unchanged cross-section. These wires are made of metal which does not corrode, deteriorate due to oxidation, or is not otherwise attacked by atmospheric ingredients or components. Preferably, I employ an alloy of nickel and chromium which appears on the market under the trade name of "Chromel A." Obviously, I do not wish to be limited to this specific material, as any other metal which has noble characteristics may be employed.

The critical point of the construction resides in the straightening out, or release, or pulling apart of the hooked connection.

I am aware that it is old to have parts soldered together or held together by a solder or soft metal rivet or the like, but those devices are subject to change in characteristics due to an approach to the melting point and a recession therefrom. In the 1 ampere fuse size I employ wires for 1 ampere rating of the order of 0.016 inch in diameter, and for 2 ampere rating of the order of 0.018 inch in diameter of the aforesaid material, and where the total length of the fusible link between the terminals 18 and 30 may be of the order of 1 inch.

The hooked engagement 22 is preferably that shown in detail in Figure 5, wherein the wire 19 has a closed loop or eye 42 formed upon the end thereof, this eye being, for example, circular and formed by bending the stock adjacent the end into a circular annular loop, with the end of the wire, as at 43, brought parallel with the main body thereof, and welded thereto. The wire 20 likewise has a loop 44 of similar configuration, but having its end 45 free. A bead of low melting point metal, for example, tin, solder or the like, is then cast about this hooked engagement, as shown in Figure 5, and this device thereupon forms a mechanical relay controlled by temperature. Obviously, instead of forming one loop completely closed by welding the end 43 as shown in Figure 5, the ends of both wires may be left open, as shown in Figure 6. In the sizes of wire shown without the metal bead 23 cast in place, a tension of only 3 to 4 pounds is sufficient to straighten out the hooked engagement sufficiently to allow the wires 19 and 20 to pull apart. But with the bead in place the hooked engagement is stronger

than the main part of the wires 19 and 20, until the bead 23 is softened by heat. When the bead 23 is softened by heat generated in the wires 19 and 20 by current flow, the wires 19 and 20 can be pulled apart by straightening out the hooked engagement at 7 pounds or less.

The conductivity of the bead 23 surrounding the hooked engagement is so great that this part of the fusible element does not become sufficiently elevated in temperature by current flow but heat is generated in the intermediate parts of the wires 19 and 20, that is, between the bead 23 and the terminals 18 and 30, and the heat is conveyed to the bead 23, bringing it up to a temperature where it softens sufficiently to permit the tension of the spring to separate the parts. The wires 19 and 20 will not soften sufficiently under heat to cause any weakening thereof short of approximately 800 to 900° C., but the metal bead 23 will soften between 200 and 300° C. There is, therefore, a wide difference in the effective temperatures of the two parts of the fusible link.

It is to be understood that the amount of spring tension which is placed upon the fusible link affects the time-current characteristic of the link. That is to say, if the spring tension is excessive, obviously it will break the link without any current flow. If the current flow is great enough to affect the temperature of the link it will affect the mechanical strength, even though the link be but a straight wire. If the wire alone be considered, no appreciable weakening in mechanical strength will be caused by current flow until the wire reaches a critical temperature, whereupon the spring tension will have a marked effect upon the time-current characteristic. The fusible element shown in Figures 1, 3, 4 and 5 is a compound device in which it is intended, as hereinabove stated, to secure an offset in the time-current characteristic flow which is idealized in Figure 9.

In that curve I have shown only the general contours and not absolute values. The continuous full line curve shows the characteristics desired. The dot-and-dash curves indicate continuations of the two independent curves which are combined by my invention. The part of the curve running from P to M is a part of a curve for one capacity of fuse. The part of the full line curve running from N to Q is part of the curve of a lower capacity link. Assume that the line M—N is a substantially vertical line and that this is placed at substantially the 60 second value, for example, it will be assumed that for values of current greatly in excess of the normal load current the blowing time is relatively short, but a marked increase of current is required if the fuse is to blow in less than 60 seconds. Within this range the wire 19 or 20 itself melts. Within the range N—Q the bead melts and releases the link. It is desirable that this should occur at as small an increase above normal load current as it is possible to secure in order that apparatus on the line, such as transformers, will not be subjected, for any appreciable period of time, to values of current flow substantially in excess of the normal rating.

In practice it is not possible to have as sharp a junction as is indicated by the vertical line M—N. In Figure 10 I have shown the shape of actual curves as plotted from tests made on fuses of this character. The lower two curves, marked Nos. 1 and 2, are curves representing the performance of one and two ampere fuses constructed in accordance with the disclosure of Figures

1, 3, 4 and 5. It will be observed that these curves are of the general shape indicated by Figure 9, the relatively sharp dips indicated in the region M'—N' showing the pronounced effect which is produced by the introduction of the bead and hook construction heretofore described.

As above indicated, the hook and bead principle may be embodied in quite different forms. For example, in Figure 5, the hooked free end 45 may be considered as a lever hinged to the main shank portion of the wire 20 with a predetermined friction at the pivot as representing the force required to swing the free end 45 into an unhooking position. Obviously, the principle would not be changed by having the free end 45 pivoted to the main shank portion without friction. This is illustrated in Figures 29 and 30. In other words, the end 45, which constitutes a lever, might be pivoted to the main shank by an actual pivot joint giving a known leverage of relatively high value. The real resistance to unhooking of the connection of these two wires resides in the molded bead 23. In order to move to an unhooking position the free end 45 must swing sidewise through the metal of the bead. To permit this the metal of the bead must be soft enough to allow the arm 45 to swing therethrough. This mode of operation is entirely different from prior devices, in which a straight wire or a wire bent into zig-zag or coiled form is embedded in a bead, since according to that construction, spring tension allows a slow creepage or lengthening of the link to occur, thereby changing its rating and rendering the device unreliable. In the present case, even if the free lever-like end 45 should begin to swing and then be halted, no appreciable lengthening of the wire 20 or the link as a whole could be detected. Hence, the characteristic of the link would not be changed, and that would be true of any position of the wire 45 short of allowing an actual unhooking or slipping through the eye 42.

In Figure 6, I have indicated open hooks on both the wire 19 and the wire 20 to give the hooked connection 22'. In practice it is not necessary or desirable to have more than one of the wires provided with an open hook, inasmuch as there is a tendency for the bead 23 to be rotated and, as the bead is oblong, it might come into a position in the fiber tube 38 which would interfere with its free rotation and expulsion. Furthermore, contact of the bead 23 with the inside of the fiber tube is not desirable, as it tends to alter the characteristics of the device.

In Figures 7 and 8, I have shown the eye 42 as provided with a small roller 47 formed of a definite exterior diameter, so as to control accurately the pivotal point about which the free end 45 will rotate. By thus providing a definite radius and conforming the end of the wire 20 to that radius, a snug and certain fit may be obtained, showing very definitely the yielding point of the link. Also, it is to be understood that instead of the two wires directly hooking with each other they may hook with an intermediate link, such as shown in Figures 29 and 30, which provides either the hook portion or the eye portion.

Whereas fuses of the low order of rating of one or two amperes present the greatest difficulty in providing a universal fuse which may be subjected to the various loads, springs, weight, and otherwise, which mountings now on the market provide, fuses as low as from 3 to 10 amperes likewise present a distinct problem. In Figure 2, I have shown in detail the construction of a 3-am-

pere fuse employing, like the fuse shown in Figure 1, a predetermined spring tension to insure the operation of the fuse in accordance with its desired time-current rating. The upper terminal member 13 is the same as that shown in Figures 3 and 4, and comprises the upper threaded stud portion 14, the intermediate flanged and grooved portion 15—16, the knurled portion 17, and the tubular collapsible socket portion 18 which is adapted to receive the corrugated upper end of the fusible wire 48 and to be pinched flat thereupon. The fitting 29a, shown in more detail in Figures 27 and 28, comprises two parts, namely, 30 and 32, which are identical with the parts of the fitting 29 shown in Figures 3 and 4, but in addition this fitting has an integrally formed metal radiating shield 49 which surrounds the major part of the wire 48 which constitutes the link 3a.

The enlarged tubular portion 49 surrounds loosely the wire 48 and lies in axial alignment out of contact with the inner walls of the fiber tube 38 in which it is contained. The small gap between the shield 49 and the upper terminal 18 prevents shunting of the fuse wire 48 but permits static or steep wave front discharges to occur from the terminal 18 to the said radiation shield 49 without traversing the wire 48. Thus, sharp static overloads which might otherwise cause blowing of the fuse unnecessarily, are ineffective to cause operation. The provision of the shield 49 forms no part of the present invention. It is disclosed and claimed in the copending application of Lindell, Serial No. 70,280, filed March 23, 1936, and assigned to the assignee of this application.

The wire 48 is preferably nickel-chromium alloy, secured upon the market under the trade name of "Chromel A." This is the same material of which the wires 19 and 20 are made. Tests show that this nickel-chromium wire retains considerable mechanical strength at elevated temperatures (even at red heat), but that a rather abrupt weakening occurs at temperatures which have been computed to be about 800° to 900° C. The melting point of these wires is approximately 1400° C.

The effect of these properties of the nickel-chromium wire is to produce a certain relationship between the flowing current and the mechanical tension, which has been utilized to render these links practically independent of external mechanical forces, within certain limits. I have made tests to determine the effect of spring tension upon the blowing time of a link. These tests show that a direct relationship exists. For example, the current required to blow a fuse wire of a diameter of .0204" in 100 seconds (this approximates the minimum fusing current for the particular terminal arrangement employed during those tests), amounted to 12.5 amperes, when no tension is applied. The current, however, decreases rapidly with increased spring tension up to about four pounds, which means that rupture occurs at temperatures below the melting point progressively approaching the critical range of from 800 to 900° C. as the tension approaches 4 lbs. for this particular size of wire, corresponding to a current of approximately 7 amperes. Any further increase in tension results in a gradual but slight decrease in the blowing current until the ultimate whole strength of the wire is reached, whereupon the blowing current abruptly drops to zero. That is to say, there is a purely mechani-

cal failure. The characteristic curves of the fuses of the structure shown in Figure 2, employing the nickel-chromium fuse wire 48, are shown in Figure 10 at curves numbered 3, 5, and 10. This arrangement of the spring 33 so that the fusible element, for example the wire 48, is non-cumulatively stressed within certain limits forms no part of the present invention but is disclosed and claimed in the hereinbefore mentioned copending application of Lindell.

In Figure 31, I have shown the fuse wire 48 of nickel-chromium alloy as shunted by a conductor 51, preferably of silver. Other low resistance metals or alloys might be employed instead. In the present instance, the silver wire 51, being of much lower resistance electrically as well as thermally, constitutes a proportioning shunt carrying the main part of the current and melting ahead of the nickel-chromium wire 48, which is now employed as a strain wire. Due to the much higher conductivity of the silver wire 51, as compared to the strain wire 48, contact between them is permissible so long as it is not appreciably varied. Hence the silver wire may be wrapped upon the strain wire, or it may be employed as a hollow tube through and beyond which the strain wire extends. Both the strain wire and the silver wire or tube are preferably mechanically gripped in tubular terminals which are pinched tight upon them.

The fuse construction embodying the silver tubular fuse element is shown in Figure 33 of the drawings. As there illustrated a fusible element in the form of a silver tube 51' is provided surrounding the strain wire 48, the ends of the latter extending beyond the ends of the former, being of zigzag shape and secured in the pinched socket portions 18 and 30', of the terminals 13 and 20' respectively. The ends of the silver tube 51' are secured in position, when the socket portions 18 and 30' are pinched thereon. As indicated, depressions are created by a suitable tool, such as a prick punch, in the pinched socket portions 18 and 30' for increasing the conductivity between them and the strain wire 48 and the fusible element 51'. The upper convolution of the spring 33 is flattened about the shoulders 34' that are formed by the flattened socket 32' in which the upper end 40 of the flexible lead 4 is secured. The tubular fusible element 51' may be spaced from the strain wire 48, as shown, which construction corresponds to that illustrated in Figure 38 in which the fuse wire 51 is spaced from the strain wire 48 or it may be in engagement therewith throughout its length, as indicated at 51'' in Figure 34, corresponding to the construction shown in Figure 31 in which the fuse wire 51 is wound tightly on the strain wire 48.

When the silver conductor forms a tube, it may serve as a corona shield serving that function of the shield 49 of Figure 2. Also it runs cooler because of the increased area. The high conductivity wire 51 may be coiled loosely about and out of contact with the strain wire 48 as shown in Figure 32.

The arrangement of the flexible lead and preloading spring in Figure 31 is the same as that shown in Figure 2.

In order to adapt the fuse links of my invention to mounting in various devices such as are now employed, I have provided the fittings or accessories illustrated in Figures 11 to 18.

Figure 11 shows a fitting 62, preferably made

of a drawn tubular piece of metal such as a copper tube, having a threaded socket 63 at the lower end for cooperating with the threaded stud 14 of the fuse of Figure 1 or of Figure 2. The upper end of the fitting is expanded or spun out to form a conical head 27 substantially identical with the head 27 shown in Figures 1 and 2. An intermediate flattened portion 64 is formed by pinching the walls of the tube together. A tongue 65 is sheared out of the upper end of the flattened metal portion 64, so that the head 27 may be broken off and the tongue 65 removed, to leave a notch 66, as shown in Figure 12, where a mounting around a bolt or pin is required for connecting the link at its upper end to a corresponding terminal.

A conical washer 28, as shown in Figures 2 and 13, may be employed, where the head is retained for mounting upon an annular seat, as will be explained later.

The terminal 67 shown in Figures 13 and 15 is similar to that shown in Figure 11, except that in this instance a tongue such as 68 is struck laterally in the flattened portion 64, so that when the head is broken off and the tongue broken out, the terminal appears as shown in Figure 15, with the notch 69 in the side edge of the flattened portion 64. This adapts the terminal for connection in certain binding post arrangements in mountings now in use. The use of partially sheared portions, which might be termed knockouts, permits the utilization of the metal for electrical and heat conductivity with ready removability. This, I believe, is broadly new.

Figure 14 shows an edge view of the structure shown in Figures 11 and 13.

In Figure 16 I have shown a link constructed in accordance with my invention, in which the upper fitting corresponding to the terminal 13 of Figures 1 to 4, instead of having a threaded stud 14 has a socket 70 in which is received and mechanically held, as by pinching thereupon, the flexible lead 72. A similar flexible lead 73, corresponding in general to the lead 4 of Figures 1 to 4, is connected to the lower end of the fusible link within the fiber tube 38. This form of link is particularly adapted to mountings in which the fuse tube is open at both ends.

In Figures 17, 18 and 26, I have shown a form of mounting in which the device of Figure 1 or Figure 2 is adapted to be employed as a complete operative fuse device in connecting a house drop conductor to a line or distribution conductor. This device comprises a connector 74 adapted to make connection with a continuous conductor such as 75, as shown in Figures 18 and 26. The secondary distribution conductors 75, 76 and 77, shown in Figure 26, are supported upon a secondary rack 78, providing suitable insulators for each conductor, the rack being mounted upon a pole 79 or the like. The drop 80 comprises, in this case, a pair of concentric conductors having leads 82 and 83 which are adapted to be connected to the secondary distribution conductors 75 and 77. The concentric pair forming the drop 80 includes a supporting strand, which may be a suitable wire cable 84, anchored upon the pole 79 through an insulating eye 85 having a threaded shank screwed into the pole. The connector 74 comprises a U-shaped body, the base of which, 86, is hexagonal in form and the parallel arms of which are threaded as indicated at 87 to receive a clamping nut 88. A transverse bar 89 having a shank 90 extending inside of the nut 88 is of a width to substantially fill the slot 92, so that

when the nut 88 is threaded down to clamp the bar 89 upon the conductor 75, the arms 87 will not be able to escape from the nut 88. A shank 90 has the edges thereof riveted over the top edge of the nut 88, so that the bar 89 and the nut 88 will remain together, even when they are removed from the fitting 74 to admit the continuous secondary conductor 75. The conductor is preferably insulated, but it has the insulation removed in order to accommodate the clamp 74. The clamp 74 has a threaded opening axially through the bottom hexagon portion 86 to receive the shank 14 of the upper terminal 13 of the link shown in Figure 1 or Figure 2. The flange 15 is screwed up tightly against the bottom or base of the hexagon portion 86 to make good electrical connection and to support the link with the fiber tube 38 in horizontal position. The flexible lead 4 is connected to the corresponding conductor of the drop 80, as shown in Figure 26. Within the fiber tube 38 is disposed the spring 33, and in the event of overload in the circuit including the conductors 82 and 83, the fusible link is fused and the lower terminal, to which the spring 33 is attached, retracts the said movable terminal such as 29a. The spring recoil, with the addition of the gases freed or formed upon blowing of the fuse, expels the terminal 29a from the tube and throws the wire 82, with the connected link 4, to the right as viewed in Figure 26, into the clear. The conductors 82 and 83 may be so disposed and formed as to facilitate this action. From this style of mounting it can be seen that the fuse link is a complete fuse device within itself, capable of maintaining its predetermined characteristics quite independently of any aid from an additional fuse tube or the mounting in which it may be disposed.

The general purpose to which this form of fuse link may be applied is illustrated in Figures 19 to 25, inclusive. Figure 25 has heretofore been mentioned, and it comprises a standard device on the market manufactured by my assignee, and is designated as the S. & C. ejector cutout. It comprises a tubular porcelain or like insulating housing 93 within which are mounted annular terminals (not shown) for making connection with the corresponding annular terminals on the fuse tube 94. The lower ferrule on the fuse tube 94 carries an arm 96 with a conical wedge-like socket to receive the conical wedge-like member 10 shown in Figure 2, the lead 4 below the said member 10 being cut off when the device is installed. The upper end of the unit 1 has the threaded stud 14 threaded into a threaded socket 97 which, in turn, is connected to the spring 50. Upon operation of the device under excessive current flow the spring 50 pulls the stud member 13 with the connected fiber tube 38 upwardly, and the spring 33 throws the lower terminal, such as 29 or 29a, downwardly. At the same time, the gases of the arc tend to assist in the expulsion of the said lower terminal, the spring 33, the flexible lead portion 40, and the plate 36.

In the operation of blowing of a device such as shown in Figure 25, employing the fuse link of Figures 1, 3 and 4, there are two ranges of operation wherein different modes of action are secured, all to a common end of accurate predetermined operation. Assume that the excess current is in the lower ranges wherein the wires 19 and 20 are heated by the flow of current but not to the point where these wires lose their mechanical strength, that is, in the region at the

right of the hump in the curves indicated at M'—N' in Figure 10. The wires 19 and 20 transmit heat to the low melting point bead 23 and, if the current is maintained for a period of time which will permit the bead to become softened to the point of allowing the hook wire to swing about through the body of the bead and become unhooked, the fuse thereupon operates to interrupt the circuit.

Inasmuch as in the device of Figure 25 the spring 50 has a pull of the order of 10 to 12 lbs., whereas the spring 33 has a pull of the order of 7 lbs., the total stress upon the fusible link is only 10 or 12 lbs. Hence, no substantial deviation from the type of curve shown in Figure 10 is occasioned by this form of mounting.

In the mounting shown in Figure 25 the fuse tube 5 is carried by the handle 98 and may be removed for renewal.

For higher values of current flow above the hump indicated at M'—N', the flow of current tends to soften the wires 19 and 20 to such an extent that they yield mechanically before sufficient heat is transmitted to the bead 23 to cause softening of the same, and fusion of the bead is not depended upon to secure opening of the circuit. In this event the wires 19 or 20 pulls apart, due to the spring tension, and the circuit is opened as above described, with the combined action of the springs and the gases formed upon blowing of the fusible link.

The fiber tube 38 is not intended to be expelled with the movable fuse terminal, as it is anchored firmly to the stud member 13. It serves the useful purpose of confining the gases and assisting in the expulsive effect, particularly on the lower current values. Also, it protects the inside of the permanent fuse tube such as 94 from injury by the arc. Also, it serves to assist in evolving deionizing gases, as it appears that the decomposition of the fiber by the arc is helpful in the action of deionizing the arc by driving gases evolved from the walls of the tube endwise of the arc to sweep out the ionized product and metal vapors. The sleeve 38, while it is preferably made of plain gray fiber, may be specially constructed to assist in the evolution of gases as by impregnating the same with a liquid or solid arc extinguishing medium, as disclosed in the patent to Ringwald, Reissue No. 19,097.

In Figure 24 I have shown the link of my invention employed in a mounting having a fuse tube 99, the upper ferrule of which has a knurled cap 100 and an annular seat for receiving the button head such as is shown in Figure 1 or Figure 3, the flexible lead 4 in this instance is attached by a clasp 103 attached to a leaf spring 104 anchored at 105 to the lower ferrule 106. Upon melting of the fuse the leaf spring 104 flips the lead wire 4 and connected lower terminal out of the lower end of the fuse tube 99. In this construction the leaf spring 104 supplies spring tension for any link which is mounted in the device. The link of my invention is interchangeable with the original fuse link supplied in connection with the mounting shown in Figure 24. In this construction the spring brackets for mounting the fuse tube are supported upon an insulating member 107 which, in turn, is adjustably mounted upon a cross-arm 108 by a suitable metallic pin clamp and bracket.

A link of my invention is interchangeable with the fuse tube and mounting shown in Figure 21. This construction comprises a box 109 having a hinged cover 110, the cover being adapted to carry

the fuse tube 112 cooperating with spring terminals 113 and 114 mounted within the box. The fuse tube 112 has an upper ferrule with a threaded cap member 115 and an annular seat for clamping the button head such as is shown in Figures 1 and 2 to make connection with said upper ferrule. At the lower end the flexible lead 4 is led out through the lower end of the open tube as indicated at 116 and the end of the lead is brought under the annular knurled nut 117 and there clamped to the surface of the lower ferrule. In this mounting there is no additional spring tension to that which is imposed by the spring 33 within the inner fiber tube 38 of the link. The operation of the device is substantially as heretofore described, that is to say, the predetermined tension of the spring 33 acting upon the fusible element causes the same to be parted when the proper current value is reached, the resultant parting assisting in expelling the flexible lead and the lower terminal and connected parts.

Obviously, in any of these mountings, if the current flow is so heavy as to result in a violent blowing of the fuse, the inner tube or sleeve, which is the sleeve 38 of the link, may be shattered, but even in such operation the inner surface of the main or outer sleeve or tube 112 is protected in large measure.

In Figure 19 I have shown the link of my invention as employed in a cutout box 118 having a lid 119. The fuse tube 120 carried upon the lid member and the ferrules 122 and 123 are provided with projecting contact springs formed of pairs of wires for engaging stationary flat studs 124 and 125 mounted on the bottom of the box member 118. The fuse tube 120 employs a retractile spring such as that indicated at 50 in Figure 25, with a flexible lead 126 connecting the threaded socket 127 and the threaded plug 128 which closes the upper end of the ferrule 122. The threaded socket 127 receives the threaded stud of the stud member 13 and the flexible lead 4 is brought out of the lower open end of the tube and brought back to a clamp terminal 129 connected with the lower ferrule 123. In this construction the spring 50 applies the main spring tension which, as in the mounting shown in Figure 25, may be in excess of that of the spring 33 of the element or link 1. The mounting shown in Figure 19 is disclosed and claimed in the copending application of Allan Ramsey, Serial No. 559,846, issued as Patent No. 2,091,452. The tension of the main retractile spring 50, working through the link 1, is sustained on the lower open end of the tube where the flexible lead 4 passes over the edge or lip of the same.

In Figure 20 I have shown a dropout type of box which is shown in detail and claimed in the copending application of Allan Ramsey, Serial No. 734,262. In this device the lid 130 which carries the fuse tube 132 is held in closed position on the box 133 by the integrity of the link 1 in the fuse tube 132. The fuse tube 132 has an upper ferrule 134 with a threaded cap 135 for clamping upon an annular seat the button head such as shown in Figures 1 and 2 to make connection with the upper terminal. The fuse tube 132 is mounted in a fitting 136 with respect to which the fuse tube may have a sliding motion under the influence of the spring to move the fuse tube downwardly to disengage the pin 137 from the latch spring 138 that connects with the upper stationary terminal 139. The lower end of the fuse tube bears upon a pivoted link 140 hinged at 142 to the fitting 136. A stationary

bracket 143 and the ferrule 134 serve to mount the fuse tube 132 on the lid 130. A cam-shaped clutch jaw 144 grips the lower end of the flexible lead 4 against the corresponding jaw on the link 140. The tendency of the spring in compression is to thrust the fuse tube 132 down against the link 140 and this reaction is taken up by the tension in the flexible lead 4 and thence in the entire link. Upon melting of the fusible element the fuse tube 132 drops down as the link 140 is no longer sustained by tension of the link 1, the pin 137 is unlatched from the spring latch 138 and the door drops open.

In Figure 22 I have indicated a mounting of the fuse tube 145 to secure a dropout effect of the said fuse tube 145 from the mounting. This mounting comprises an upper stationary bracket 146 comprising a hood containing suitable contacts and including a spring-mounted pin 147 which is adapted to be engaged by the hook 148 formed on the movable sleeve 149 of the upper ferrule 150. A compression spring between the sleeve 149 and the stationary ferrule member 150 tends to throw the hook 148 upwardly. The sleeve 149 has a threaded cap 25 for clamping the button head of a suitable spring mounting. A tension spring 50, shunted by a suitable flexible conductor 126 carries at its lower end a threaded coupling 127 as in Figures 19 and 25 and the stud member 13 of Figures 1 and 2 is threaded into said fitting 127, whereby the upper portion of the link 1 is mounted within the lower end of the fuse tube 145, the flexible lead 4 is carried down to the lower end of the extension on the ferrule 152 and connected under a binding post 153. When the fusible link melts or yields the spring 50 pulls the stud and tube 38 upwardly, releasing the sleeve 149 and permitting the hook 148 to travel upwardly and detach itself from the pin 147. Thereupon the spring contacts which bear upon the sleeve 149, and gravity, throw the fuse sleeve 145 in a clockwise direction about the trunnion 154, taking the fuse tube 145 out of the circuit.

In Figure 23 I have shown another form of mounting which is on the market. The fuse tube 155 in this structure has an upper ferrule 156 and a lower ferrule 157. The upper ferrule 156 has an opening through the same permitting the sleeve 38 of my link to be passed therethrough, allowing the button head 27 to project. A finger 158 projects upwardly from the upper ferrule 156 and is designed to pass between a pair of spring rods 159 forming the upper terminal. These spring rods press downwardly, both to make contact with the button head 27 and to throw the fuse tube 155 into open position when the fuse element of my link melts. The lower ferrule 157 has an arm 162 pivoted to a bell crank lever 163, one end of the lever being held against the lower end of the fuse tube 155 by the flexible lead 4 which is fastened under the binding post 160. The bell crank lever 163 has a hook about the trunnion 164, which trunnion is mounted on the lower stationary terminal of the mounting. The downward thrust of the spring rods 159 is sustained by the link 1 which holds the arm 165 of the bell crank lever 163 against the lower end of the fuse tube 155. When the link 1 is ruptured by melting of the fusible element the downward thrust of the spring rods 159 and the weight of the fuse tube 155 tends to cause a rotation of the bell crank lever 163 in a clockwise direction about the trunnion 164. This action pulls the flexible lead 4 outwardly in the tube 155. At the

same time the fuse tube 155 descends and as the button head escapes from under the hump 166 in the spring rods 159, the fuse tube 155 drops out of the circuit.

From the above illustrations it can be seen that the fuse link of my invention is interchangeable in a wide variety of mountings which now employ fuse links of the prior art.

The above illustrated mountings are but typical examples of mountings in which the fuse of my invention may be utilized.

From the above it will now be apparent that I have provided a fuse link suitable for employment in a wide variety of mountings, in which there is a predetermined spring tension to control the time-current curve according to a desired mode of operation. This spring tension is great enough for the very low ampere fuses such as one or two amperes, to overcome the hooked engagement of the fuse wires when the bead melts. Mere melting of the bead does not release the hooked connection of the wires, and this spring tension is therefore necessary to secure opening of the circuit for current values which are lower than those which would actually melt the wires such as 19 and 20. In this manner it is possible to secure a very delicate response to low current values while employing parts of ample mechanical strength and dimensions.

I believe that the hook and bead principle is broadly new. I am aware that it has been attempted to hold parts together by solder, wax and various other expedients, but in all of the structures with which I am familiar, there is no positive mechanical engagement such as I have obtained by the use of the hook and eye, independently of the bead or solder.

Another feature of my invention above described is the provision of attachments and fittings for making the fuse applicable to a wide variety of mountings. A particularly important feature is the employment of the threaded stud with interchangeable terminal parts, whereby the link may be applied to a wide variety of terminal fittings.

Furthermore, the link of my invention is a complete fuse within itself, and may be so employed, as shown, for example, in Figure 26. In this form it is suitable for lower voltages, such as 110 to 220. Obviously, by changing the proportion of parts the voltages may be carried higher.

The fuse employed in Figures 17-18 and 26 may omit the spring where the fuse rating is great enough to provide the expulsive action.

Numerous other advantages in manufacture and operation will be apparent to those skilled in the art.

I do not intend to be limited to the details shown and described.

I claim:

1. In combination with a fuse link comprising a first fuse terminal member, a second fuse terminal member, and a fusible element connecting said terminal members, a fiber tube having one end bound upon said first member, said member having a threaded stud projecting out of the end of the tube, a flexible lead connected to the second member, and a fitting having a flanged head at one end, a flat intermediate portion, and a tubular threaded socket at the other end threaded upon said stud.

2. An adapter for fuse links of the class described, comprising a hollow tubular metal member of a soft metal of high conductivity having a flanged conical head at one end and a tubular internally threaded socket at the other.

3. An adapter for fuse links of the class described, comprising a hollow tubular member of cuprous metal having a flanged conical head at one end, an intermediate flattened portion, and a tubular internally threaded socket at the other.

4. A fuse link comprising a pair of terminals, a strain wire connecting the terminals, a tubular conductor of high conductivity surrounding the strain wire and interconnecting said terminals, a sleeve of insulation surrounding the strain wire and said tubular conductor, and a spring normally stressed and tending to separate said terminals.

5. The combination of a fuse device comprising a fuse of the tubular expulsion type, clamping means at one end of the tube for rigidly securing it to a selected point on a power wire, a flexible lead at the opposite end of said tube for connection with a drop wire, and a spring inside of said tube for discharging said flexible lead away from the fuse device when the fuse blows.

6. In a replaceable fuse link a pair of terminals, a tubular conductor interconnecting said terminals, and a strain wire positioned inside of said tubular conductor and also interconnecting said terminals.

7. In a replaceable fuse link a pair of terminals, a fusible conductor in the form of a silver tube interconnecting said terminals, and a strain wire also interconnecting said terminals, said strain wire being disposed within said silver tube.

8. In a fuse device a pair of terminals, and a pair of concentrically arranged fusible conductors disposed in contact with each other and interconnecting said terminals and secured thereto by frictional engagement therewith, one of said conductors consisting of silver.

9. In a fuse device a pair of relatively massive terminal members, a fusible element in the form of a tube interconnecting said terminal members, and a strain element positioned within said tube and interconnecting said terminal members for relieving said fusible element of stress tending to separate said terminal members.

10. A replaceable fuse link comprising a fuse tube impregnated with an arc extinguishing material which is adapted under the action of an arc to give off a gaseous arc extinguishing medium, a fuse terminal at one end of said fuse tube, a flexible lead extending out of the other end of said fuse tube, a tubular fusible element composed principally of silver interconnecting said fuse terminal and said flexible lead, a tension spring disposed around said flexible lead inside said fuse tube and reacting between the same for extending the gap formed on blowing of said fusible element, and a strain wire inside of said tubular fusible element and interconnecting said fuse terminal and said flexible lead for relieving said fusible element of the stress imposed by said spring.

11. An adapter for fuse links of the class described, comprising a hollow tubular metal member of high conductivity having a flanged head at one end, an intermediate flattened portion, and a threaded portion at the other end.

12. A fuse link comprising a pair of terminals, a strain wire and interconnecting said terminals connecting said terminals, a tubular conductor of high conductivity surrounding said strain wire, and a sleeve of insulation surrounding said strain wire and said tubular conductor.

13. In a fuse link, a strain wire having corrugated end portions, and a pair of terminals

having tubular end portions adapted to be pinched upon said corrugated end portions.

14. In a fuse link, a strain wire having corrugated end portions, and a pair of terminals having tubular end portions, said end portions being generally deformed upon said corrugated end portions and also locally deformed thereon.

15. In a fuse device, a pair of relatively infusible terminal members, a fusible element in the form of a tube secured to and interconnecting said terminal members, a strain element also interconnecting said terminal members for relieving said fusible element of stress tending to separate said terminal members, and means anchoring said strain element to said terminal members independently of said fusible element.

16. In a fuse device, a pair of terminals, and composite fusible conductor means interconnecting said terminals, said composite fusible conductor means including a tubular silver sheath of such cross-sectional area that it conducts a substantial portion of the current flowing between said terminals.

17. In a fuse device, a pair of spaced apart terminals having tubular portions facing each other, and composite fusible conductor means disposed in said tubular portions for interconnecting said terminals, said tubular portions being deformed onto the ends of said composite fusible conductor means therein, said composite fusible conductor means including a tubular silver sheath of such cross-sectional area that it conducts a substantial portion of the current flowing between said terminals.

18. In a fuse device, a pair of spaced apart terminals having tubular portions facing each other, and composite fusible conductor means disposed in said tubular portions for interconnecting said terminals, said tubular portions being deformed onto the ends of said composite fusible conductor means therein, said composite fusible conductor means including a sheath of metal characterized by being of relatively high conductivity as compared to the remainder of said composite fusible conductor means and of such cross-sectional area that it conducts a substantial portion of the current flowing between said terminals.

19. A renewable fuse link comprising, a pair of relatively infusible terminals, a flexible lead connected to each of said terminals, a fusible element interconnecting said terminals, spring means biasing said terminals apart and tensioning said fusible element, and a fuse tube surrounding said terminals and said fusible element.

20. A renewable fuse link comprising, a pair of relatively infusible terminals, a flexible lead connected to each of said terminals, a fusible element interconnecting said terminals, and a fuse tube substantially longer than the distance between said terminals and surrounding the same and said fusible element.

21. In a fuse link, a metallic core, a tubular metallic container surrounding said core, a pair of flexible conductors formed by a plurality of strands of wire, and a pair of tubular terminal connectors each having one end adapted to receive said core and container and the other end adapted to receive one of said flexible conductors.

22. In a fuse link, a metallic core, a tubular silver container surrounding said core, a pair of flexible conductors formed by a plurality of strands of wire, a pair of tubular terminal connectors each having one end adapted to receive said core and container and the other end adapt-

ed to receive one of said flexible conductors, and a sleeve of insulation surrounding said container and said terminal conductors.

23. In a replaceable fuse link, a pair of terminals, a tubular fusible element electrically interconnecting said terminals, and a strain element mechanically interconnecting said terminals in such manner that tension stress between said terminals is applied directly to said strain element.

24. In a fuse, a pair of spaced apart terminals having tubular end portions extending toward each other, and a tubular fusible element interconnecting said terminals and having its ends telescoped with said tubular end portions, the ends of said tubular fusible element and said tubular end portions being deformed to provide electrical connection therebetween.

25. In combination with a fuse link comprising a first fuse terminal member, a second fuse terminal member, and a fusible element connecting said terminal members, a fuse tube having said first fuse terminal member at one end and surrounding said second fuse terminal member and said fusible element, a flexible lead connected to said second fuse terminal, and a fitting having a flanged head at one end and a flat intermediate portion and arranged and adapted to be detachably connected to said first fuse terminal member.

26. A renewable fuse link comprising, a fuse tube, a terminal at one end of said fuse tube, a flexible lead extending out of the other end of said fuse tube, fusible means interconnecting said terminal and said flexible lead, a threaded stud on said terminal, and a fitting having a flanged head at one end, a flat intermediate portion, and a tubular socket at the other end threaded upon said stud.

27. In a fuse link, in combination, a terminal fitting, fusible means connected to said terminal fitting, a sleeve of insulation surrounding said fusible means and closely surrounding said terminal fitting, and a retaining ring surrounding said sleeve and holding it in position.

28. In a fuse link, in combination, a terminal fitting having a terminal attaching portion at one end and a fusible element receiving portion at the other end, a fusible element secured to said fusible element receiving portion, a sleeve of insulation surrounding said fusible element in spaced relation and at one end closely surrounding said terminal fitting intermediate said portions, and a retaining ring shrunk around said end of said sleeve and holding it in position.

29. In a fuse link, in combination, a terminal fitting having a terminal attaching portion at one end, a fusible element receiving portion at the other end and a knurled portion intermediate said ends; a fusible element secured to said fusible element receiving portion, a sleeve of insulation surrounding said fusible element in spaced relation and at one end disposed around said knurled portion, and a retaining ring shrunk around said one end of said sleeve and holding it in position on said knurled portion.

30. In a fuse device, a pair of spaced apart terminals having tubular portions, and composite fusible conductor means disposed in said tubular portions for interconnecting said terminals, said tubular portions being deformed onto the ends

of said composite fusible conductor means therein, said composite fusible conductor means including a tubular silver sheath of such cross-sectional area that it conducts a substantial portion of the current flowing between said terminals.

31. In a fuse device, a pair of spaced apart terminals having tubular portions, and composite fusible conductor means disposed in said tubular portions for interconnecting said terminals, said tubular portions being deformed onto the ends of said composite fusible conductor means therein, said composite fusible conductor means including a sheath of metal characterized by being of relatively high conductivity as compared to the remainder of said composite fusible conductor means and of such cross-sectional area that it conducts a substantial portion of the current flowing between said terminals.

32. In a fuse link, two terminals and a fusible element connecting them, and prestressed means maintaining said fusible element under predetermined mechanical tension of such value that said fusible element will part at a predetermined current rating and any increase in tension imposed on said element within the limits of its mechanical strength leaves the current rating thereof substantially unaltered, whereby the current rating of said element is maintained substantially constant irrespective of increased tension thereof.

33. In a fuse link, an insulating sleeve, a pair of fuse terminals and a fusible element connecting them, one of said terminals being mounted on said sleeve and restrained thereby against movement in a direction toward the other terminal, and prestressed means connected to said other terminal and anchored to said sleeve reacting thereon toward said first terminal, said means maintaining said fusible element under predetermined mechanical tension of such value that said fusible element will part at a predetermined current rating and any increase in tension imposed on said element within the limits of its mechanical strength leaves the current rating thereof substantially unaltered, whereby the current rating of said element is maintained substantially constant irrespective of increased tension thereof.

34. In a fuse link, an insulating sleeve, a pair of fuse terminals and a fusible element connecting them, one of said terminals being mounted on said sleeve and restrained thereby against movement in a direction toward the other terminal, and a prestressed spring attached at one end to said other terminal and having its other end anchored to said sleeve, said spring reacting upon said sleeve toward said one terminal and cooperating with said sleeve for maintaining said fusible element under mechanical tension, the stressing of said spring being such that said element is maintained under tension of such value that it will part at a predetermined current rating and any increase in tension imposed upon said element within the limits of its mechanical strength leaves the current rating of said element substantially unaltered, whereby the current rating of said element is maintained substantially constant irrespective of increased tension thereof.

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