L. W. DOWNES & R. C. PATTON.

FUSE.

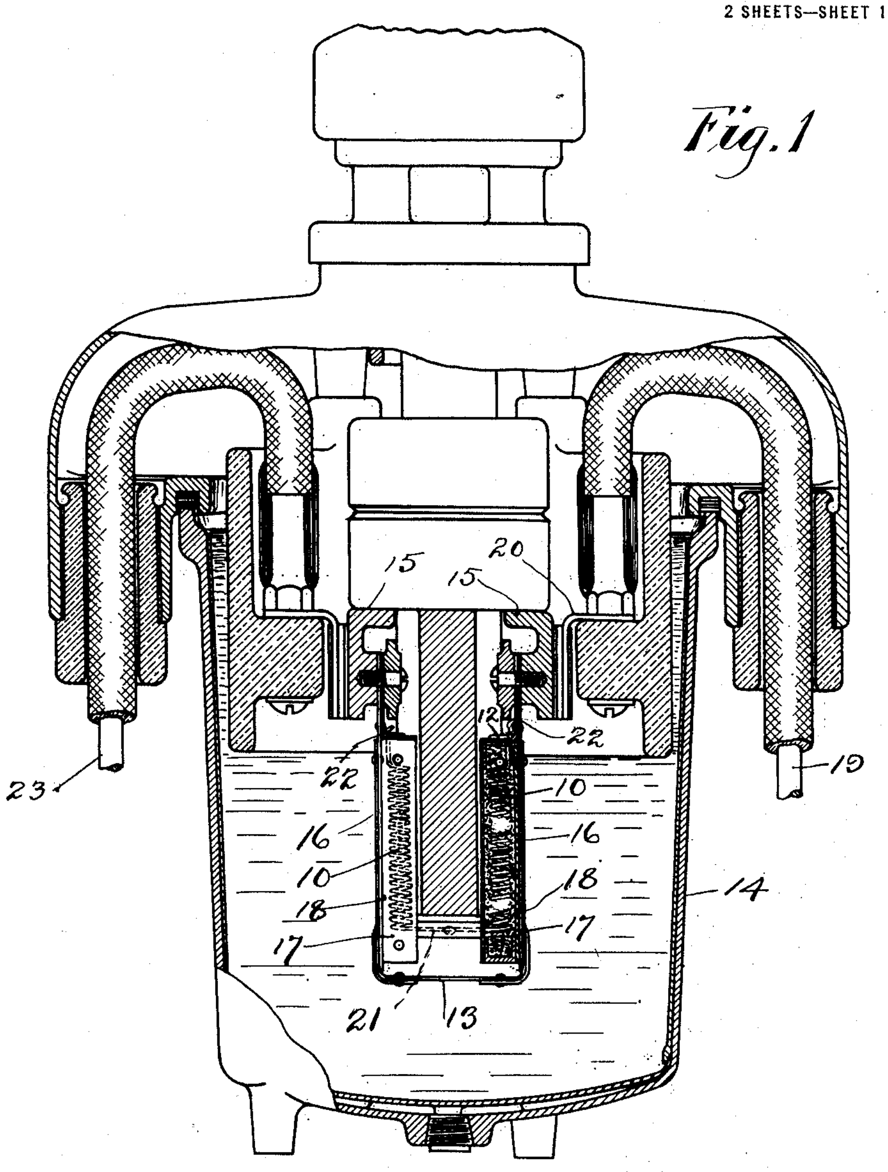
APPLICATION FILED FEB. 26, 1917.

1,248,090.

Patented Nov. 27, 1917.

2 SHEETS—SHEET 1.

Fig. 1



Witnesses

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2 SHEETS—SHEET 2.

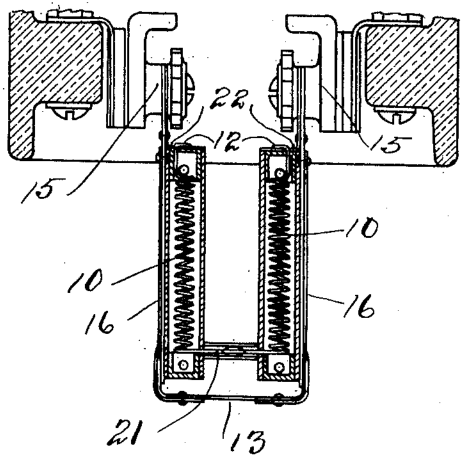

Fig. 2

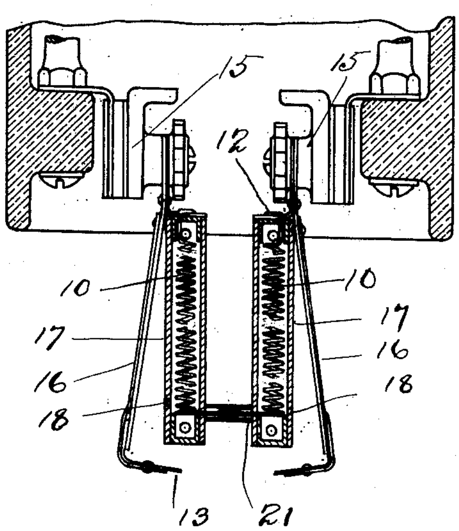

Fig. 3

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FUSE.

1,248,090. Specification of Letters Patent. **Patented Nov. 27, 1917.**

Application filed February 26, 1917. Serial No. 150,873.

To all whom it may concern:

Be it known that we, LOUIS W. DOWNES and RALPH CLIFTON PATTON, citizens of the United States, and residents of the city of Providence, in the county of Providence and State of Rhode Island, have invented certain new and useful Improvements in Fuses, of which the following is a specification.

This invention relates to electric fuses of the class adapted to be connected in an electric circuit to open it when an overload or short circuit occurs, and the object of this invention is to provide a compound fuse of that type in which two or more fusible elements are connected together, the elements being constructed in such a way that but one will fuse at a time.

A further object of this invention is to provide a main fusible link or element of a given ampere capacity, and an auxiliary link of a greater resistance, part of the latter being wound into a coil, preferably of helical form, whereby an excessive current flow first opens the main link and is then automatically shunted through the auxiliary link of coil form which opens soon after. By this construction a fuse of high voltage and current rating can be made to operate quietly and without violence even when an excessive current is passed therethrough.

A still further object of this invention is to provide a main fusible link connected electrically in parallel with an auxiliary link, the main link being surrounded by a liquid arc suppressing material, and that portion of the auxiliary link which is intended to fuse being surrounded by a permeable granular or fibrous arc suppressing substance soaked with the arc suppressing liquid.

A still further object of this invention is to provide a main fusible link connected electrically in parallel with an auxiliary fusible link, the main link being attached to spring terminal strips under tension so that when a portion of the main link melts, the remaining stubs of the link are quickly moved apart by said tension so as to aid in breaking the electric arc between the main link stubs, the movement of the spring terminal strips being the same as described in Patent No. 1,203,316, issued Oct. 31, 1916.

It is found in practice that when fuse links of the non-helical or straight type not under mechanical tension are called upon to interrupt greatly excessive currents at high voltages, much of the link is instantaneously converted into vapor, frequently in a violent and explosive manner. But when a properly proportioned compound link, consisting of a main link under mechanical tension tending to separate its ends, and an auxiliary link of greater resistance connected electrically in parallel with it, both the main and auxiliary links being immersed in liquid arc suppressing material, and that portion of the auxiliary link which is intended to fuse being coiled and surrounded also by a permeable granular or fibrous arc suppressing substance, is caused to open a greatly excessive current at high voltage, the rupture of the current is effected with great ease and with practically no disturbance. The quiet operation of this form of compound link is due to the following sequence of phenomena:

When the excessive current traverses the fuse, the main link melts first because it carries a greater proportion of the total current than does the auxiliary link of higher resistance, and also because the auxiliary link when properly designed usually has a higher melting point than does the main link. As soon as the middle portion of the main link is destroyed, the spring terminal strips separate the remaining stubs of the link very rapidly so that a large gap is immediately formed to interrupt the current. As soon as the passage of current through the main link is stopped, the current is forced to flow through the auxiliary link alone. Since the auxiliary link or circuit has a much greater resistance than the two links in parallel had, and because the auxiliary link's shape is that of a choke coil, the current is materially reduced, being partially restrained by the high resistance and the choking action of the coiled portion. The flow of current through the auxiliary link is still further reduced because of the increasing resistance of this link brought about by its rapid rise in temperature. When the auxiliary link reaches its melting point, some part of its coiled portion fuses, thus stopping even the restricted current flow which traverses this circuit after the main link blows.

When the main link melts, it does so without violence as it is not required to entirely interrupt the current flow, but merely to shunt it through a somewhat more difficult path. When the auxiliary link fuses or blows, the rupture of the current is effected without violence because the current has been reduced to small value before this happens, and also because the rupture takes place in the presence of suitable liquid and permeable granular or fibrous arc suppressing materials.

An essential feature of our improved type of compound fuse is that an auxiliary link, a portion of which is coiled and surrounded by both liquid and permeable granular or fibrous arc suppressing materials, is mounted to operate in combination with a main link held in tension by spring terminal strips, the auxiliary link being of greater resistance than the other. Thereby the opening of the link of less resistance shunts the current into the link of greater resistance and both links blow quietly, owing to the rapid breaking of the arc at the main link, and the presence of proper arc quenching materials about each link. Thus the combination of the two links operate quietly and safely by breaking the current in successive steps instead of all at once.

It has been found by experiment that when the coiled portion of the auxiliary link is surrounded by the liquid arc suppressing material only, the blowing of the link may be accompanied by considerable violence as the arc suppressing liquid becomes heated sufficiently to be partly transformed into gas, which we find to be undesirable. By surrounding the coiled portions of the auxiliary link with both the permeable granular or fibrous arc suppressing material and the arc suppressing liquid in the manner shown in the drawings and described hereinafter, excessive heat radiation during the passage of the shunted current is prevented. Therefore, the auxiliary link reaches its melting point in a very short time after the main link blows.

It has been determined experimentally that the evolution of gas from the arc suppressing liquid in the region of the coiled portions of the auxiliary link is effectively reduced by surrounding these portions with a combination of permeable granular or fibrous arc suppressing material and the arc suppressing liquid. It has been observed that the coiled portions of the auxiliary link when surrounded by the combined arc extinguishing materials in this way have a tendency to rupture at a number of separated points, whereas, a coiled link not so surrounded usually fuses at only one point. Thus it is seen that the coiled portion of the auxiliary link acts much more positively in opening the circuit when surrounded by the combined arc suppressing materials than when surrounded by the liquid alone. Therefore, the permeable granular or fibrous arc suppressing material and the liquid arc suppressing substance coöperate to produce the proper arc quenching effect when placed around the coiled portions of the auxiliary link.

With these and other objects in view, the invention consists of certain novel features of construction, which will be more fully described and particularly pointed out in the appended claims.

In the accompanying drawings:

Figure 1—is a longitudinal section showing a compound link immersed in liquid arc suppressing material, supported in one form of suitable container.

Fig. 2—is a side elevation showing the compound fusible link attached to terminal blocks as it appears before being blown by an excessive current, and showing the auxiliary link casing in section.

Fig. 3—is the same as Fig. 2 but showing both of the links as having been blown by an abnormal flow of current.

It is found in practice that a liquid arc suppressing material such as certain kinds of oil may be used to great advantage, particularly in fuses of very high voltage rating. One type of such fuse is illustrated in Fig. 1 in which two helical fuse links 10 are connected to work in combination with a flat link 13. These compound forms of fuses may be arranged to operate in any style of casing or casings. That shown in Fig. 1 being a receptacle 14 which is filled with a liquid arc suppressing material and in which is mounted the main link 13 supported from the terminal blocks 15 by the spring terminal strips 16.

The tubular casings 17 are preferably filled with a suitable granular or fibrous or otherwise porous or intersticed arc suppressing material in which they are immersed, which liquid enters the casings 17 through the openings 18 therein.

It is found in practice that when this auxiliary coil is surrounded by such a combination of arc suppressing materials that its action is much more positive and effective and that the fuse blows much more quietly than when surrounded by either the liquid or the porous material alone.

The operation of this form of fuse when carrying a current is as follows:—The current enters through the terminal conductor 19, passes through the contact strip 20, the terminal block 15, and into the upper end of the spring strip 16. The current thereupon divides, the most of it traveling down through the remainder of the spring strip 16, across the fusible element 13 and up through the other spring strip 16. The smaller remaining portion of the divided current traverses the coils 10 and the wire 21. The two components of the current reunite before entering the other terminal block 15, and the whole current then passes out through the remaining terminal conductor 23.

The separate coils 10 which are connected by the wire 21, shunt a small portion of the total current because these coils are joined at their upper ends to the spring strips 16 by means of the clips 22. When a fuse is constructed with a main link of the flat type and an auxiliary link of the helical type, and an overload or short circuit occurs on the line, the main strip is melted at once and the current is shunted through the helix of greater resistance and reactance. This shunting action reduces the potential across the terminals of the main fusible strip and thus greatly reduces the violence of the arc at that point.

As the helical link contains a relatively large amount of metal and as its melting point is usually higher than the main link, it has a relatively greater heat storage capacity. Therefore the time required to heat it to its melting point is somewhat greater than the time required to fuse the main link. This effect renders the operation of the coil a little more sluggish than the straight or non-helical forms, and allows an inductive circuit to be opened without undue potential fluctuations and surges which would ensue with any very quick opening link. These voltage rises and surges are often injurious to the general insulation of the system and therefore the slightly retarded interruption of the current flow in the coil link accomplishes the rupture of the current in a most advantageous way by reducing these surges. During the brief interval elapsing between the blowing of the main link and the auxiliary coil link, the current rise is impeded and held partially in check by the counter electromotive force developed in the helix and by its relatively high resistance. This counter electromotive force is due to the coil shape of the conductor which forms the auxiliary link. The coil link has a typically inductive shape which possesses the well-known characteristic of developing counter electromotive force to oppose the potential tending to send a rising current through it. It is, therefore, seen that inasmuch as the main link melts while shunted by the helix it operates quietly, and that the coil link melts an instant later while the current is restrained, thus the opening of the circuit is accomplished without undue voltage fluctuations and without disturbance.

We have shown and described one illustrative embodiment of our invention, but we desire it to be understood that the details of construction may be varied without departing from the spirit of the invention, the scope of which is defined and limited only by the appended claims.

We claim:

1. An electric fuse comprising a fuse link, a casing for said link, and an intersticed arc suppressing filling in said casing saturated with a liquid arc suppressing material.

2. An electric fuse comprising a fuse link formed in a helical coil, a casing for said coil, and a filling of intersticed arc suppressing material saturated with a liquid arc suppressing material in said casing about said coil.

3. A compound electric fuse comprising a main link, and an auxiliary link, said main link being inclosed in a main receptacle and surrounded by a liquid arc suppressing material, and said auxiliary link being mounted in an auxiliary casing within the main casing.

4. A compound electric fuse comprising a main link and an auxiliary link, said main link being inclosed in a main receptacle and surrounded by a liquid arc suppressing material and said auxiliary link being mounted in an auxiliary casing within said main casing, said auxiliary casing containing an intersticed arc suppressing material.

5. An electric fuse comprising a main link and an auxiliary link, said main link being inclosed in a main receptacle and surrounded by a liquid arc suppressing material and said auxiliary link being mounted in an auxiliary casing within the main casing, and means in said auxiliary casing for admitting the liquid from the main casing.

6. An electric fuse comprising a main link and an auxiliary link, said main link being inclosed in a main receptacle and surrounded by a liquid arc suppressing material and said auxiliary link being mounted in an auxiliary casing within the main casing and containing an intersticed arc suppressing material, and means in said auxiliary casing for admitting the liquid from the main casing whereby the filling therein becomes saturated with said liquid.

7. A compound fuse comprising a main link, an auxiliary link of helical form connected in parallel with said main link, a casing for said auxiliary link having a filling of intersticed arc suppressing material, and a casing inclosing both of said links and containing a liquid arc suppressing material in which said links are submerged.

8. A compound fuse comprising a main link, an auxiliary link connected in parallel

with said main link, a casing for said auxiliary link having a filling of intersticed arc suppressing material, a casing inclosing both of said links and containing a liquid arc suppressing material in which said links are submerged, and means for automatically operating the fused members of the main link after blowing.

In testimony whereof we affix our signatures in presence of two witnesses.

LOUIS W. DOWNES.
RALPH CLIFTON PATTON.

Witnesses:
GEORGE W. STEERE,
H. F. MACGUYER.