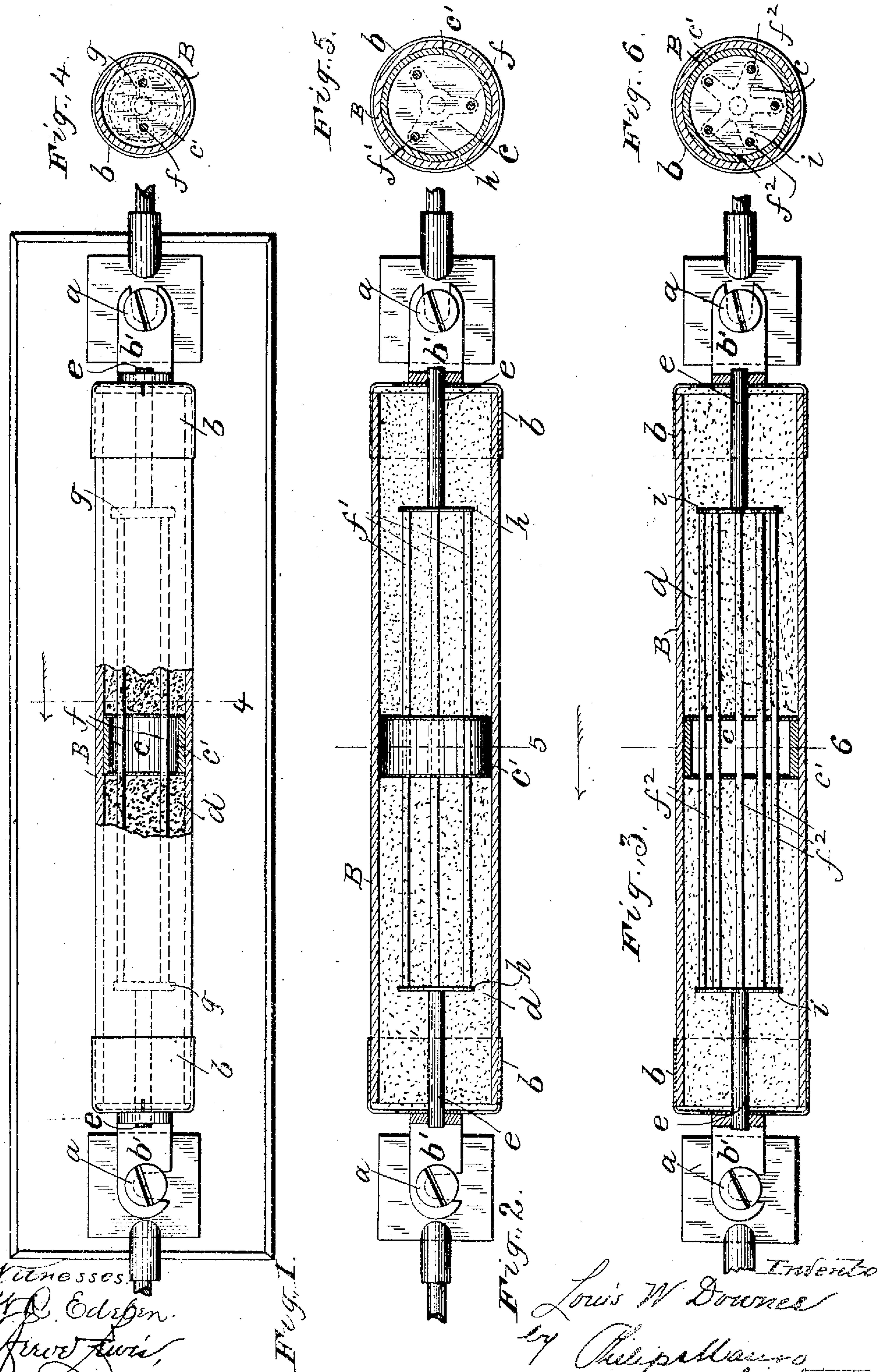
No. 640,371. Patented Jan. 2, 1900.

# L. W. DOWNES.

## ELECTRIC FUSE OR CUT-OUT.

(Application filed Apr. 12, 1899.)

(No Model.)

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# UNITED STATES PATENT OFFICE.

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## ELECTRIC FUSE OR CUT-OUT.

SPECIFICATION forming part of Letters Patent No. 640,371, dated January 2, 1900.

Application filed April 12, 1899. Serial No. 712,728. (No model.)

*To all whom it may concern:*

Be it known that I, LOUIS W. DOWNES, a citizen of the United States, and a resident of the city of Providence, State of Rhode Island, have invented a new and useful Improvement in Electric Fuses or Cut-Outs, which invention is fully set forth in the following specification.

My present invention relates to improvements in electric fuses, but more particularly concerns the construction of what is known in the art as the "fuse-link," this being the short length of fusible metal which is adapted to be heated and melted upon the passage through the fuse of an overload or excessive current.

A brief discussion of the conditions under which fuses operate, of the factors affecting such operation, and of the requirements to be met will facilitate a clear and complete understanding of the invention and of the description thereof which is to follow. As is well known, the principle involved in all fuses is the raising to its melting-point of a short length of metal by the passage of a current therethrough. Under ordinary conditions it may be said that for a certain cross-section and length of this metal there will be a certain definite temperature rise for a certain current strength. The temperature rise in a fuse does not, however, in practice bear that definite relationship to the current that might at first be expected, for the reason that it is very greatly affected by certain variable conditions or factors. The principal of these is the ability of the fuse to throw off the heat, which, so far as the fuse-link or wire itself is concerned, is largely governed by its superficial dimensions, the position of the fuse-links, the condition of the surrounding atmosphere as to whether it is in motion or quiet, which is a still more uncertain factor than either of those before mentioned, and whether or not the fuse-link itself is in contact with any body whose ability to absorb the heat developed is greater than that of air. It will be seen that a condition may exist where the rate of radiation or loss of heat by the fuse equals the rate at which the heat is developed. There will then exist a state of equilibrium, and should the temperature be just below that at which the metal softens the fuse will be carrying its maximum current. If now the current is increased slightly, the rate of development of the heat becomes more rapid than the rate of dissipation, with the result that the temperature increases gradually and in time the melting-point will be reached. This increase in the current value will constitute an overload, since it is in excess of the maximum current that the fuse will carry. With a further increase in current the balance is further disturbed, the rate of radiation remaining the same, while the rate of development of heat is more rapid than before, with the result that the time required to bring the mass to the melting-point is considerably less, or, in other words, the time factor for any given overload becomes rapidly less as the current increases, the time factor being the time required to bring the fuse to its melting-point from the moment of the increase of current. The two most important of the variable factors which affect the rate of radiation of the fuse are probably the exposure to draft and contact with adjacent bodies. In a draft the heat is far more rapidly taken up by the passing air than if it were quiet, while by contact with a body, such as porcelain or metal, whose rate of absorption of heat is greater than that of air an equilibrium may be established for the time being until the body itself becomes heated. Under such conditions it will be found that a fuse will require a much longer time before it is brought to the melting-point. Another feature of uncertainty of much the same nature is the effect the fuse-terminals have in changing this time factor. If the fuse metal is connected to very massive terminals which will rapidly absorb the heat, the time factor will be materially increased. If, however, the terminals are small and light, so that they possess but small comparative heat-conducting power, they can have but little effect in changing this. To correct these defects, then, it becomes necessary to fix all the otherwise variable factors in order to secure a device the melting-point of which for any given overload is practically constant. Its superficial area must be a fixed quantity. It must be protected from air-drafts and so placed that the amount of contact with any adjacent material is a fixed value. In my

Patent No. 569,373, dated October 13, 1896, I have shown and described a fuse which, as has been practically demonstrated, successfully and satisfactorily meets all of the requirements of ordinary usage. It has been found, however, that in fuses above certain sizes, particularly those adapted to carry heavy currents without blowing, trouble is frequently caused when said fuses are subjected to a severe overcharge of current, owing to the fact that the volume of metal volatilized by the action of the current and requiring dissipation was so great that there was apt to be a severe explosion due to the sudden expansion of the comparatively large volume of metallic vapor. Several ways have been tried with a view to overcoming this difficulty, among them being the use of an alloy of high conductivity, by which means the cross-section of the link would be materially reduced; but it has been found that all alloys of high conductivity—such as alloys of tin, copper, and the like—whatever the bulk of the metal, vaporize with what may be called "explosive" action, whereas metals of less conductivity, such as lead or lead alloys, can within certain limits as to bulk be transformed from metal to vapor instantly without any great disturbance under suitable conditions; but in fuses of large capacity a single fuse-link of lead or lead alloy must necessarily be of large cross-sectional area, and therefore of considerable bulk, and is therefore apt to vaporize with an explosive action for the reasons above set forth.

In accordance with my present invention I obviate the difficulties above referred to by employing instead of a single wire fuse-link of large sectional area or bulk, a fuse-link composed of a plurality of wires or metallic bodies connected in parallel or multiple arc. By such construction several advantageous results of major importance are secured, the first being an actual reduction of the total cross-sectional area involved—that is to say, the sum of the cross-sectional areas of, say, two, three, or five small wires is less than the cross-sectional area of one large wire necessary to carry a given amount of current. This is due to the fact that the total surface area of five small wires is much greater than that of a single large wire, with the result that it possesses greater ability to radiate the heat occasioned by the passage of the current. A second result is that the metal being already separated into smaller divisions there is greater opportunity, when the metal is volatilized by the passage of an excessive current, for the gases thus evolved to expand and diffuse themselves in the filling surrounding the fuse-link. It thus becomes possible to handle with fuses of comparatively small dimensions, particularly as to diameter, but having large current-carrying capacity, severe discharges without trouble or disturbance of any kind.

My invention will be more fully understood by reference to the accompanying drawings, wherein—

Figure 1 is a plan view, partly broken away, showing a fuse embodying my invention wherein the multiple fuse-link is composed of two fusible sections of wire connected in parallel. Fig. 2 is a view partly in section and partly in elevation, the fuse-link in this instance being composed of three fusible sections of wire. Fig. 3 is a view similar to Fig. 2 of a fuse wherein the link is composed of five fusible sections. Fig. 4 is a section on line 4 of Fig. 1. Fig. 5 is a section on line 5 of Fig. 2. Fig. 6 is a section on line 6 of Fig. 3.

Referring to the drawings, *a a* are two binding-posts mounted on a suitable base and between which the fuse is removably connected.

B is an inclosing tube preferably made of a non-conducting fibrous material and closed at its ends by perforated brass caps *b b*.

*c* is an air-space about the middle of the fuse-link formed by a suitable drum *c'*.

*d* is a filling of a suitable material preferably in a finely-divided state, (such as slaked lime,) the principal function of which is to provide a multitude of minute paths or interstices for the escape of the vapor or gas evolved upon the volatilization of the fuse-link by an excessive current.

As thus far described the fuses shown in the drawings do not differ materially from that shown in the patent above referred to.

The fuse-links shown in the drawings may be said to comprise three sections—viz., two end sections each consisting of a single short rod or wire *e e*, projecting at their outer extremities, respectively, through openings in caps *b b* and also through openings in the vertical arms of angle-pieces *b' b'*, wherein they are soldered. Said angle-pieces form the terminals of the fuse and are adapted for engagement with the binding-posts *a a*, respectively. The central section of the fuse-link consists of a plurality of wires *f*, preferably of lead or lead alloy, passing through the ends of drum *c'*, and hence penetrating air-space *c*. At their opposite ends these wires are connected to the inner ends of rods *e e*, respectively, in such manner that current entering on one rod *e* divides in proper proportion over the wires *f*, but leaves the fuse by the other rod *e*. In other words, the current passes over the wires *f* in multiple arc.

The multiple fuse-link shown in Figs. 1 and 4 has two wires *f f*, connected at their extremities to the rods *e e* by means of plates *g g*, bent as shown in Fig. 4, to which said parts are soldered.

In Figs. 2 and 5 the central section of the fuse-link consists of three wires *f'*, which are connected to the rods *e e* by means of three-armed spider-plates *h h*. The extremities of the rods are soldered in central perforations through these plates, while the extremities of the wires *f* are soldered, respectively, in perforations in the ends of the three arms of said plates.

In Figs. 3 and 6 I have shown five wires $f^2$, connected with the rods *e* by two five-armed spider-plates *i i*.

In operation it will be understood that when an excessive current passes through the fuse the plurality of wires composing the central section of the fuse-link will be melted simultaneously at a point within drum *c'*, at which point the temperature is the highest, the air confined within said drum being a poorer conductor of heat than the filling *d* which surrounds the wires outside of the drum.

While I have herein described and illustrated my multiple fuse-link in connection with a fuse having other features—such as the central air-space, filling of finely-divided material, &c.—my present invention is in no manner limited in its application to fuses having such other features. Furthermore, it will be understood that modifications may be made within wide limits without departing from the principle of the invention. It is also apparent that the multiple fuse-link may constitute an article of manufacture separate from the other parts of the fuse. As the burning out of a fuse-link does not destroy the inclosing sheath and other parts, they may of course be employed again with a new fuse-link.

What I claim as new, and desire to secure by Letters Patent, is—

1. In an electric fuse or cut-out, the combination with an inclosing sheath, and terminals on said sheath, of a fuse-link within the sheath consisting of a plurality of fusible wires or conductors connected in parallel between said terminals, and a filling of suitable porous or similar material within the sheath about said fusible wires providing a multitude of interstices or passages for disintegrating or breaking up and conducting away the metallic vapor or gas evolved by the fusing of the wires.

2. In an electric fuse or cut-out, the combination with an inclosing sheath, and terminals on said sheath, of a fuse-link within the sheath consisting of a plurality of fusible wires or conductors connected in parallel between said terminals, an air-space within the inclosing sheath traversed by said wires, and a filling of suitable porous or similar material within the sheath about said fusible wires providing a multitude of interstices or passages for disintegrating or breaking up and conducting away the metallic vapor or gas evolved by the fusing of the wires.

3. In an electric fuse or cut-out, the combination with an inclosing sheath, of two caps, one for closing each end of said sheath, terminal connections on said caps, a fuse-link consisting of two end sections, each in the form of a single metallic rod or wire projecting through the caps respectively and in electrical contact with the terminals thereon, and an intermediate section consisting of a plurality of fusible wires or conductors connected in parallel between the inner ends of the two end sections respectively, an air-space within the sheath and through which said fusible wires pass, and a filling of a suitable material within the sheath.

4. In an electric fuse or cut-out, the combination with an inclosing sheath, and terminals on said sheath, of a fuse-link within the sheath consisting of three or more fusible wires or conductors connected in parallel between said terminals and disposed about an imaginary axis at equal distances from each other, an air-space within the sheath traversed by said fusible wires, and a filling of suitable porous material within the sheath.

5. In an electric fuse or cut-out, the combination with an inclosing sheath, and terminals on said sheath of a fuse-link within the sheath consisting of three or more fusible wires or conductors connected in parallel between said terminals and disposed about an imaginary axis at equal distances from each other, an air-space within the sheath traversed by said fusible wires, and a filling of suitable porous material within the sheath.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

LOUIS W. DOWNES.

Witnesses:
IRA L. FISH,
JAMES H. THURSTON.