No. 620,309.

Patented Feb. 28, 1899.

W. S. HADAWAY, Jr.

ELECTRIC FUSE.

(Application filed Apr. 27, 1898.)

(No Model.)

Fig. 1.

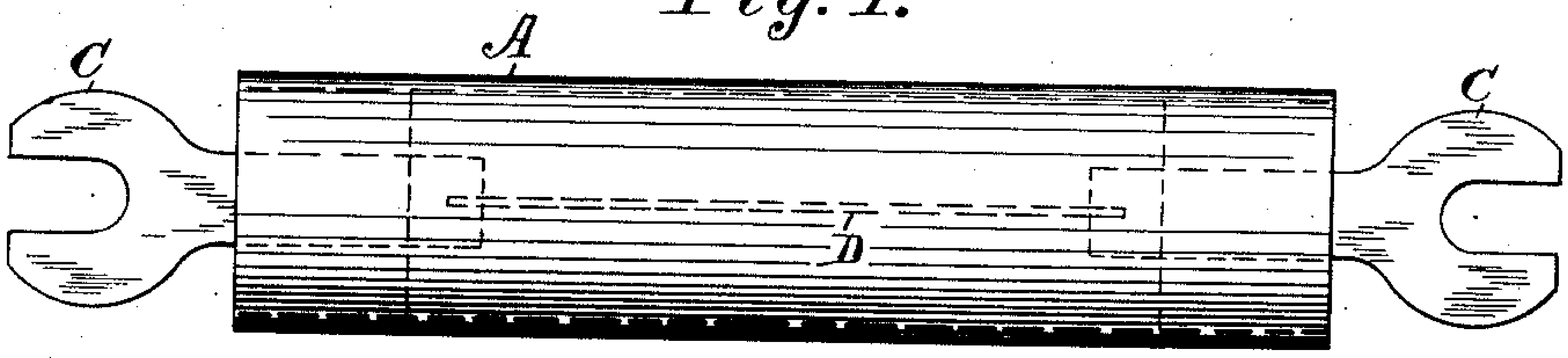


Fig. 2.

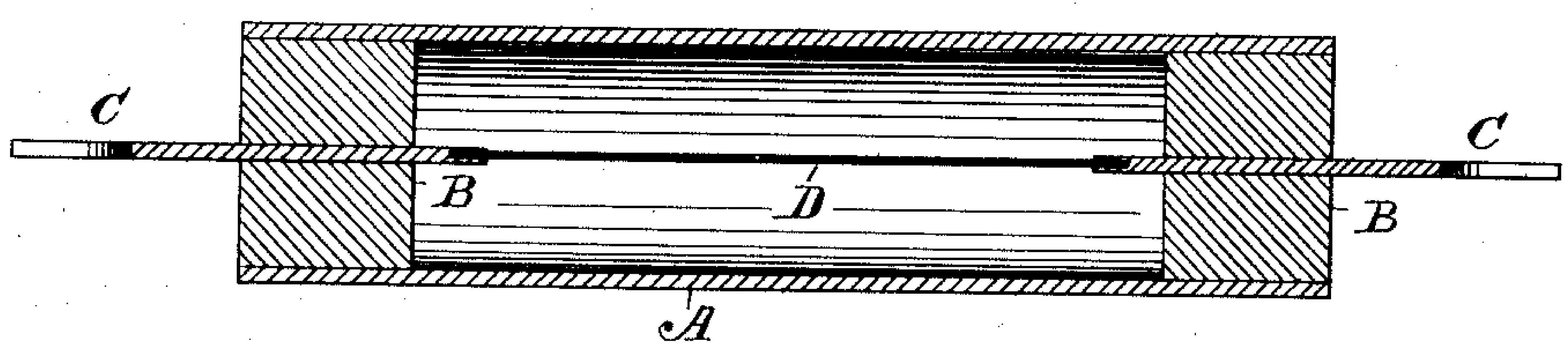


Fig. 3.

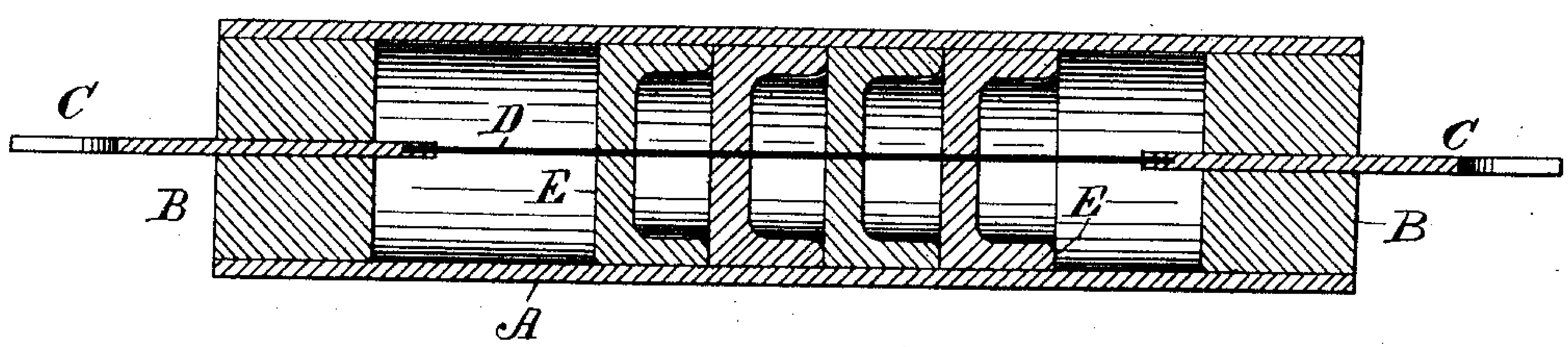


Fig. 5.

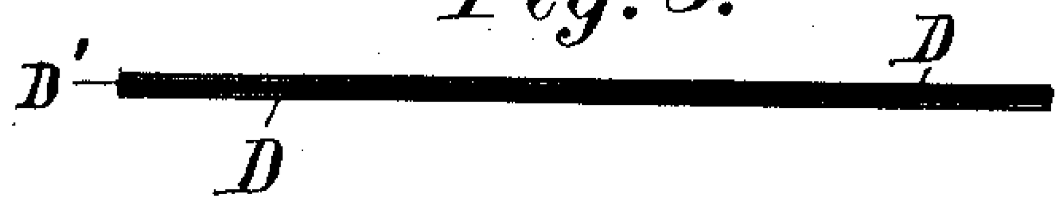
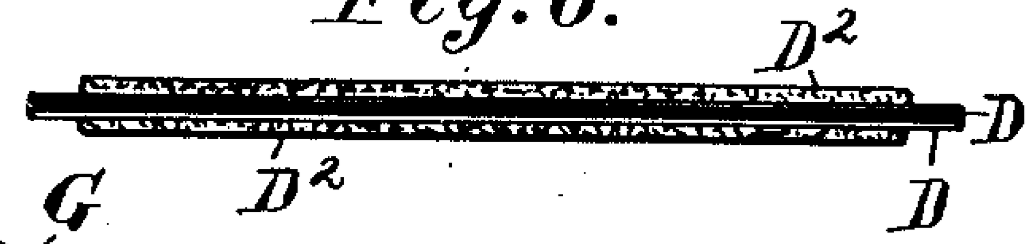
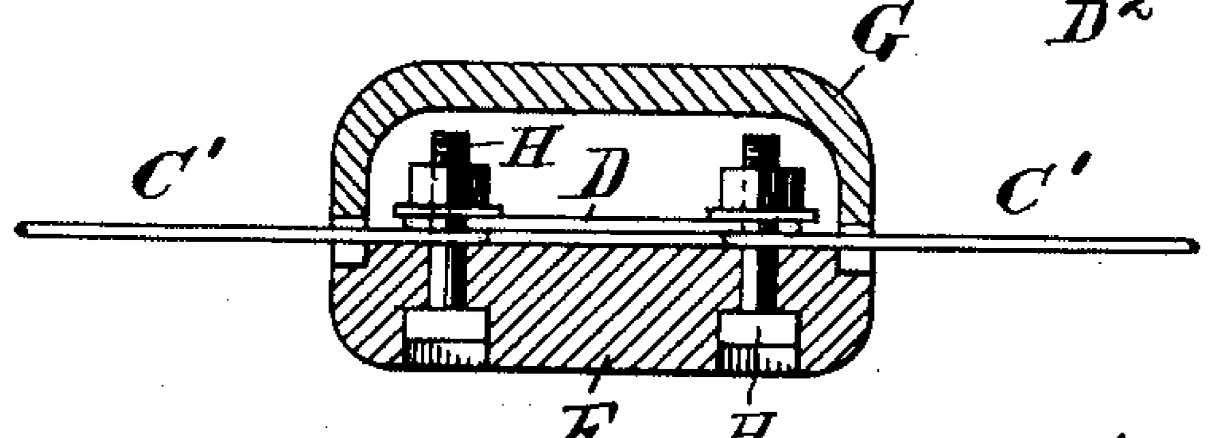


Fig. 4.

Fig. 6.





Attest:
L. Lee.
Edw. P. Kinsey

Inventor.
William S. Hadaway Jr.
per Thomas S. Crane, Atty.

UNITED STATES PATENT OFFICE.

WILLIAM S. HADAWAY, JR., OF NEW YORK, N. Y.

ELECTRIC FUSE.

SPECIFICATION forming part of Letters Patent No. 620,309, dated February 28, 1899.

Application filed April 27, 1898. Serial No. 678,998. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM S. HADAWAY, Jr., a citizen of the United States, residing at New York, county of New York, State of New York, have invented certain new and useful Improvements in Electric Fuse, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

The object of the present improvement is to secure the conversion of the fuse wire or strip into an insulating substance below the temperature at which the fuse will melt and to thus avoid the formation and dispersion of heated particles which may do injury to surrounding objects. This result is obtained in the present invention by employing the metal magnesium to constitute the entire fuse or as a coating for a fuse-strip of other metal, as copper, the magnesium in the latter case producing a decomposition of the copper with great rapidity and at a definite temperature greatly below that at which the copper would fuse. I have discovered that magnesium will combine rapidly with the oxygen of the atmosphere when heated by the electric current to a temperature which is below the melting-point of the magnesium. The oxidation of the metal progresses at a more rapid rate when the air is under a pressure greater than that of the atmosphere, and such increased pressure is secured in the present invention by confining the fuse-wire in a tight chamber in which the pressure of the contained air is increased by the heat generated in the fuse. The temperature at which the magnesium is oxidized may be governed with still greater accuracy by coating the magnesium of the fuse with a layer or shell of oxygen-bearing material, such as binoxid of manganese, (MnO_2,) which gives up its oxygen at a definite temperature below the melting-point of magnesium. When a fuse wire or strip conducting a current with high voltage is melted by an excess of current, an arc is sometimes formed between the several particles of the melted metal and is thus extended by steps over the space between the circuit-terminals. The operation of my fuse is entirely different, as its whole exterior is first converted into magnesia by the oxidizing action, thus diminishing the cross-section of the fuse wire or strip and the amount of current carried thereby. As the oxidation progresses the entire wire carries less and less current until the conversion is complete and the current is wholly interrupted. The high conducting power of copper makes it most desirable for a fuse; but experience has shown that a copper fuse is gradually deteriorated by the oxygen of the atmosphere, which is combined with the copper at a temperature considerably below that due to its carrying capacity. The capacity of the fuse is thus gradually diminished, so that it is liable to be burned out by a current which it was designed to carry with safety. By coating the copper wire with magnesium its oxidation and deterioration are wholly prevented and it is adapted for use as a fuse at a temperature far below the melting-point of copper by the burning away of the magnesium at such low temperature, which operates to reduce the carrying capacity of the fuse, while the temperature of the burning magnesium also raises the temperature of the copper and produces a rapid oxidation and conversion of the latter into a non-conducting substance. The magnesium coating upon the copper serves to remove many of the objections to this type of fuse in that the temperature produced by the electric current can never exceed that of the melting-point of magnesium, and the combination of the magnesium with the copper furnishes an effective means of varying the time factor with an overload of current, as the time required to burn out the fuse is decreased in proportion as the thickness of the magnesium coating is increased. The fuse is thus converted into a mass of insulating material which forcibly resists the passage of current and affords no points to conduct an arc by steps between the terminals, and my construction is thus peculiarly adapted for use with high-voltage currents. To prevent positively the formation of an arc between the terminals with currents of high voltage, the chamber in which the fuse (with a limited body of air) is inclosed may be intercepted by one or more diaphragms of insulating material, as compressed fused magnesia or carbid of silicon. The fuse passes through such diaphragms, and when it is converted into magnesia the product fills the perforations in the diaphragms and operates to obstruct the passage of an arc, and thus prevents the formation or maintenance of an arc between the terminals.

These improvements will be understood by reference to the annexed drawings, in which—

Figure 1 is an elevation, and Fig. 2 a longitudinal section, of a fuse with inclosing tube. Fig. 3 is a longitudinal section of a similar construction with diaphragms inserted in the tube. Fig. 4 is a longitudinal section of an ordinary fuse-block with the magnesium wire joined to the circuit-terminals upon screw-studs. Fig. 5 is a longitudinal section of a copper fuse-strip coated with magnesium, and Fig. 6 is a longitudinal section of such a strip coated with manganese binoxid.

A designates a tube of vulcanized fiber or other insulating substance, and B porcelain plugs cemented in the ends of the tube and having the fuse-terminals C extended through the same. I find that silicate of soda mixed with fine sand forms a pasty cement adapted to secure the plugs firmly in the ends of the tube.

D designates the fuse wire or strip, formed of the metal magnesium and attached to the terminals in any suitable manner. The outer ends of the terminals C are formed in any suitable manner to make connection with the circuit-wires, the form shown in the drawings being adapted to clamp in spring-holders in the usual manner.

The plugs B confine the air within the tube, so that when heated by a rise of temperature in the fuse the pressure of the air is increased and the oxidation of the metal when commenced at a suitable temperature is more rapid than with air at a normal pressure.

In Fig. 3 four diaphragms are shown inserted within the tube between the plugs B, the diaphragms being readily molded of suitable form with a central perforation to permit the passage of the fuse wire or strip. The wire is fitted snugly to the perforation, so that when it is converted into magnesia, which results in considerable expansion of its volume, the passage through the diaphragm is closed by the insulating substance thus formed. As the fuse is heated uniformly throughout its entire length when traversed by an excess of current, it is converted simultaneously into magnesia throughout its entire length, and after such conversion there is nothing remaining within the fuse-tube to conduct the current or to initiate the formation of an arc.

If the fuse wire or strip were broken at any point during the conversion and an arc were formed at such point, the arc would be ultimately broken by the further conversion of the strip into magnesia and the plugging of the holes in the diaphragms, which would each assist in resisting the passage of the arc.

I have found that the diaphragms perform an additional function in modifying or affecting the time required to discharge or break the fuse, as the wire heats more rapidly when unconfined between its terminals and exposed wholly to the air than when intersected by the diaphragms, which cause it to heat more slowly. Where the fuse without the diaphragms would be broken in one minute with a given current, the interposition of a suitable number of the diaphragms will operate to extend the time to one and a half minutes or two minutes, whichever may be desired. The diaphragms thus adapt the fuse for use with currents of high voltage and serve to regulate the time within which an excess of current may be maintained in the circuit.

Fig. 4 shows the ordinary bug cut-out, having a porcelain body F and cover G, with studs H, upon which the terminals C' are wound, as well as the ends of the fuse-wire D. In this construction the magnesium wire or strip when converted into magnesia becomes a nonconductor of electricity and heat and furnishes no products of a dangerous character adapted to injure surrounding objects if it be displaced from its supports.

Fig. 5 shows the composite fuse formed of a wire or strip D' of copper or other metal with a coating of magnesium D. Such strip may be used in any of the constructions shown, operating as follows: The magnesium burns off when the temperature reaches the intended point, and the combustion of the magnesium raises the temperature of the other metal, which is also being rapidly raised by the electric current, owing to the burning away of the magnesium. The joint effect of such combustion and of the current upon the copper core is to speedily break the latter and open the circuit.

Fig. 6 shows the composite strip coated with binoxid of manganese D^2, which is preferably applied in a pasty form with any suitable adhesive medium and dried upon the fuse-strip, so as to adhere permanently.

All the oxids of manganese give up a part of their oxygen at a temperature which is considerably below the melting-point of magnesium, and the binoxid of manganese when decomposed by heat forms protoxid of manganese and sets free at a definite temperature a proportion of oxygen which unites rapidly with the magnesium and converts it into magnesia. This in the case of the composite wire reduces the carrying capacity of the fuse-strip and increases the temperature of the copper or other metallic core, so as to burn it out rapidly.

The association of the magnesium with the binoxid of manganese produces a fuse whose burning-point can be regulated in the most definite manner, as the decomposition of the oxid occurs at a known point. As the binoxid of manganese operates by combination with the magnesium, it may of course be applied to a solid magnesium fuse-strip like that shown in Fig. 2. A fuse having a magnesium body or covering may be combined with the manganese binoxid in any convenient manner, as by packing the powdered binoxid in a tube around the fuse-strip; but an adherent coating is preferably like that shown in Fig. 6, as it consumes less of the binoxid and avoids the use of a confining-tube.

The composite fuse formed of copper or other metal with magnesium coating and having a coating of manganese binoxid may be advantageously used within the air-tight tube A, as shown in Fig. 2, as the copper affords a conductor of the smallest dimensions for a given capacity, while the magnesium prevents the deterioration of the copper and secures the burning of the fuse at a temperature below its melting-point and without the formation of an arc, while the binoxid of manganese regulates in the closest manner the temperature at which the circuit shall be broken.

From the above description it will be seen that the magnesium wire or strip employed in my construction is not fused or melted at all, although I have termed it a "fuse wire or strip" herein, because the term "fuse" is generally employed for thermal devices for interrupting an electric circuit when an excess of current is formed in the same.

The primary feature of my invention is the use in an electric fuse of magnesium which oxidizes below the point of fusion, and the secondary features of the invention are the use of such magnesium as a coating for copper or other metal and the combination with the magnesium of a coating of manganese binoxid to effect the oxidation of the magnesium at a perfectly definite temperature dependent upon the heating of the binoxid.

Having thus set forth the nature of the invention, what I claim herein is—

1. In an electric fuse, a magnesium wire or strip employed to conduct and to break the current, and adapted to oxidize below the point of fusion, and thus forming an infusible conductor under such conditions, substantially as set forth.

2. An electric fuse comprising an insulating-tube with plugs at the ends having fuse-terminals projected through the same, a series of magnesia diaphragms fitted within the tube between the plugs and a magnesium wire or strip extended through the diaphragms, substantially as herein set forth.

3. An electric fuse of copper or other metal having a coating of magnesium adapted to oxidize below the fusing-point of magnesium, and thus to heat the metallic core while diminishing the capacity of the fuse-strip, substantially as herein set forth.

4. An electric fuse having a magnesium body or covering, in combination with an environment of manganese binoxid adapted to furnish oxygen to oxidize the magnesium at a definite temperature, substantially as herein set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

WILLIAM S. HADAWAY, JR.

Witnesses:
EDWARD F. KINSEY,
THOMAS S. CRANE.