Dec. 24, 1929. T. E. MURRAY 1,740,699

ELECTRIC FUSE

Filed Feb. 7, 1928

Fig. 1.

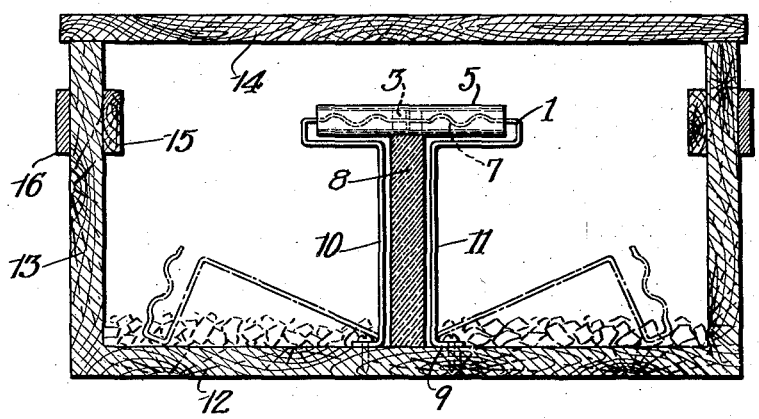


Fig. 2.

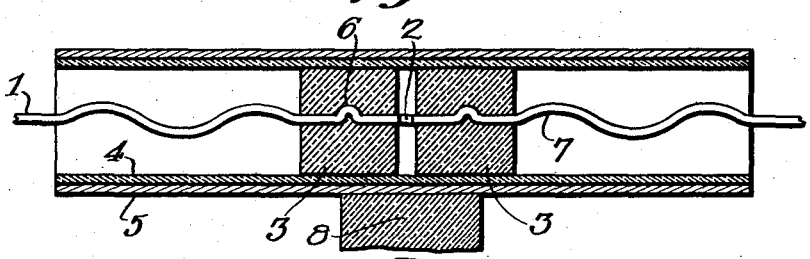


Fig. 3.

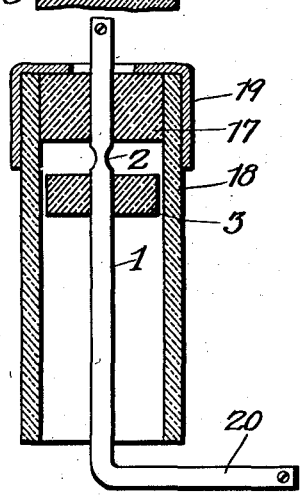
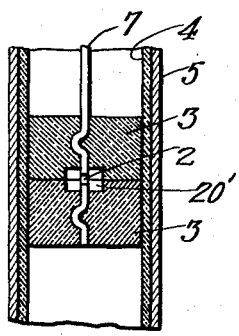


Fig. 4.



Inventor

THOMAS E. MURRAY.

By His Attorney

Anthony Udina

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UNITED STATES PATENT OFFICE

THOMAS E. MURRAY, OF BROOKLYN, NEW YORK; JOSEPH BRADLEY MURRAY, THOMAS E. MURRAY, JR., AND JOHN F. MURRAY, EXECUTORS OF SAID THOMAS E. MURRAY, DECEASED

ELECTRIC FUSE

Application filed February 7, 1928. Serial No. 252,439.

The invention aims to provide certain improvements in fuses designed particularly for high voltages but applicable also for ordinary or low voltages.

The present application is a continuation in part of my previous application No. 755,135, filed December 11, 1924.

The accompanying drawings illustrate embodiments of the invention.

Fig. 1 is a side elevation of a fuse enclosed in a large casing, the casing being in section;

Fig. 2 is a vertical section of the fuse strip and adjacent parts of Fig. 1;

Fig. 3 is a vertical section of a modification.

Fig. 4 is a similar section of another modification.

Referring to the drawings the fuse strip or element 1 is provided at an intermediate point in its length with a portion 2 of reduced cross section to form a localized blowing point. Near the blowing point, according to Figs. 1 and 2, are heads or plungers 3, one on each side, separated from each other by a slight space. These plungers are adapted to move freely in a cylinder preferably composed of an inner insulating tube 4 of fibre and an outer tube 5 of stronger material such as iron or steel to withstand the force of the explosion. The heads 3 may be of fiber, heat-treated wood or other suitable material. When the fuse blows or burns out at the narrow part 2, the gas generated therein will separate the heads 3 forcibly and promptly forcing one or both of them so rapidly out of the open ends of the tube that any arc formed at the blowing point will be unable to follow the widely separated parts of the fuse strip. The strip may be fastened in the plungers 3 in any suitable way. For greater security they may be bent as at 6, Fig. 2, before being imbedded in the heads. The outer portions may be curved as at 7 to yield more easily to the force of the explosion.

The chief difficulty involved in the use of fuses on high voltage circuits is a tendency of the current to form and retain an arc between the burned ends of the fuse, with generation of large quantities of gas. The imbedding of the ends of the sections in the heads or plungers as shown diminishes the dangerous possibilities in this direction. The arc will not follow the fuse strip for any substantial distance into the heads. Particularly will it be stopped by the crooked direction of the fuse strip in the head as shown in Fig. 2.

Furthermore the location of the heads 3 in the cylinder 4 produces a piston or plunger effect and a wide separation of the ends of the strip after a blow and thus further reduces the chance of establishing or maintaining an arc.

In a previous patent of Thomas E. Murray, Jr., No. 1,120,226, dated December 8, 1914, a fuse is shown so arranged that the gas generated upon a blow will force the ends of the two sections apart. A similar operation is obtained in the present case, with the addition of the heads 3 with a confined space between them which will cause the gas pressure to throw the heads violently apart, and with the additional protection provided by the imbedding of the ends of the broken strip in the heads, and particularly the crooked shape of the strip in such heads.

The space for confining the gases may be closely restricted, as in the Murray patent referred to above; or the clear space between the heads 3 may be somewhat greater, as in the present drawings, equal to or slightly in excess of the length of the restricted portion of the fuse strip, giving more room for the generation of gas.

The tube in Fig. 1 is carried on the top of a post 8 of insulating material. The fuse strip passes up from terminals 9 at the bottom of the post, to the top of the same and around and into the open ends of the tube 5. Thus, we have a repulsion effect between the two parts 10 and 11 of the fuse or conductor on opposite sides of the porcelain or other non-conducting post 8 as described in a patent of Thomas E. Murray, Jr., No. 1,073,619 dated September 23, 1913, which itself tends to throw the ends of the fuse apart when the reduced portion thereof burns through. In addition, we have plenty of room for the heads or pistons when they are thrown apart. The apparatus is carried in a case with a bottom 12, side walls 13 and top 14 which may be

of wood, for example, and plates 15 of wood are located on the inside in position to receive the blow of the expelled plungers 3 with metal reinforcing strips 16 on the outside. When a blow occurs the pistons and the ends of the fuse will be blown out against the parts 15 and to approximately the positions indicated in dotted lines; thus effecting a quick and wide separation of the ends of the fuse. With such an arrangement on a 15,000 volt current of 25 cycles, using a 200 ampere fuse, I have opened the circuit in from three to five cycles; the tube in this case being two and one-half inches in diameter and eighteen inches long. And with a 100 ampere fuse I have opened the same circuit in half a cycle.

Instead of using two movable heads or plungers 3, a single such plunger may be used, as in Fig. 3, confining the gas by a fixed abutment 17 at the opposite side of the reduced section 2 of the fuse strip. The abutment 17 is fixed in the upper end of a tube 18 of non-conducting material, the latter being strengthened by a metal cap 19. The lower end of the strip 1 is bent laterally as at 20 to facilitate the easy expulsion of the plunger with the portion of the strip to which it is attached.

The plunger does not need to fit tightly in the tube. In Fig. 3, I have illustrated a somewhat greater clearance than in Fig. 2. The closeness of fit required for practical success depends on the capacity and voltage of the fuse and also on the length of the plunger. If the plunger is long, the fit need not be so good as when the plunger is comparatively short. It must be such that the plunger is expelled from the tube, carrying with it the attached part of the fuse strip. This aim is facilitated by permitting the plunger to move easily through the tube, and also by the vertical arrangement of Fig. 3 with the plunger below the contracted portion of the strip and with the lower end of the tube open and the strip bent around out of the vertical line.

With this design, I have obtained satisfactory tests under short circuit conditions at 6600 volts and with fuse capacities up to 100 amperes. I have also operated this same general type at 11,000 volts and have opened short circuit loads the equivalent of 150,000 kw. These fuses may, therefore, be used as substitutes for circuit breakers of the complicated types now generally thought necessary on lines carrying heavy loads.

The vertical arrangement of Fig. 3 gives this advantage, that the single movable plunger is expelled in a downward direction. But a double-ended tube, like that of Fig. 1, for example, may also be used efficiently in a vertical position expelling one plunger downward and the other upward. Such an arrangement is shown in Fig. 4. In addition this figure shows a modification in the shape of the plungers 3. One or both of these plungers is formed on its inner face with a recess 20′. The plungers are brought face to face. Thus the recesses 20′ provide a more limited space than is allowed in the previous constructions where such spaces are of the full cross section of the plungers. The same method of restricting the space may be applied to the other constructions illustrated.

By expelling the plungers, with the ends of the burned fuse, to an unlimited distance the circuit cannot be re-established, as might be the case, particularly on high tension lines, where the ends of the burned fuse remain within a distance from each other which is limited by the ends of the casing. The blowing of the fuse fills the space with a vapor of the metal which is highly expansible and conductive and will, therefore, immediately re-establish the circuit if the tension therein be great enough to form an arc of this gas. This is particularly true where the separated pistons remain in a casing from which the gas cannot escape or can escape only slowly.

The space between the plungers or abutments is regulated according to the character of the fuse metal and the volume of gas which will be generated. The plungers will limit the fuse metal gasified to that portion located between their adjacent faces, with allowance for the gasification of a portion extending slightly into the plungers. There must be enough gas generated to move the plungers promptly and swiftly out of the casing or to a distance well beyond that through which the calculated volume of gas will carry the current by an arc. Any excess of gas beyond that needed is objectionable because of its highly conductive character. The movement of the plunger or plungers should be substantially free so as to oppose no resistance to the explosive effect of the gas and to permit operation with a minimum quantity of gas.

The space in which the fuse element is exposed is made so slight in proportion to the current carried that the consumption of all the fuse metal in this space is assured. And further consumption beyond the determined amount is prevented by the pistons as above explained, so that the amount of metal to be consumed is regulated by the length of such space.

The ends of the case are a considerable distance beyond the plunger. This guides the plungers and gives a prolonged pressure driving the plungers with an accelerating velocity. It also confines the highly conductive gas, or metal vapor, for a substantial distance beyond the blowing point, so as to prevent its spreading to conductors at the opposite end of the tube and making a short circuit.

Various other modifications than those described may be made by persons skilled in the art without departure from the invention as defined in the following claims.

What I claim is:

1. A fuse comprising an open-ended case, a plunger within said case at a substantial distance from its end, an abutment, a fuse element engaged by said plunger and having a blowing point between the abutment and the plunger so that the gas generated by the blowing of the fuse is confined, the case being unobstructed from the plunger to the end of the case so that the plunger with its engaged portion of the fuse element is moved promptly and swiftly away from the blowing point and is permitted to move freely through the case and out of the open end thereof when the fuse blows.

2. A fuse comprising a case open at opposite ends, plungers within said case, a fuse element engaged by said plungers and having a blowing point between them so that the gas generated by the blowing of the fuse is confined between said plungers, the case being unobstructed from the plungers to the ends of the case so that the plungers with their engaged portions of the fuse element, are moved promptly and swiftly away from the blowing point and through the case and out of the open ends thereof when the fuse blows.

3. A fuse comprising a case, a fuse element having a blowing point, a plunger in which the portion of the fuse element near the blowing point is encased and an abutment separated from the face of said plunger by a distance less than the diameter of the plunger so as to confine the gas generated by the blowing of the fuse in the slight space thus provided and to cause the plunger with its encased portion of the fuse to be moved promptly and swiftly away from the blowing point when the fuse blows, the end of the case in rear of said plunger being open to permit the plunger to move freely through and out of the case on the blowing of the fuse.

4. A fuse comprising an open-ended case, a plunger within said case, an abutment, a fuse element engaged by said plunger and having a blowing point between the abutment and the plunger so that the gas generated by the blowing of the fuse is confined and the plunger, with its engaged portion of the fuse element, is moved promptly and swiftly away from the blowing point and is permitted to move freely through the case and out of the open end thereof when the fuse blows and a receptacle for the blown plunger outside of said case.

5. A fuse for opening an electric circuit, comprising a fuse element having a blowing point, means whereby the blowing of the fuse will displace the ends of the fuse element adjacent to the blowing point to such a distance that the circuit cannot be re-established by the passage of the current through the gas generated and means for confining such gas for a substantial distance beyond the blowing point of the fuse.

6. A fuse for opening an electric circuit, comprising a fuse element having a blowing point, a plunger engaging the fuse element near the blowing point, means for displacing said plunger with its portion of the fuse element upon the blowing of the fuse to such a distance that the circuit cannot be re-established by the passage of the current through the gas generated, and means for confining such gas for a substantial distance beyond the blowing point of the fuse.

7. A fuse comprising a case, a plunger within the case, an abutment, a fuse element engaged by said plunger and having a blowing point between the abutment and the plunger, the portion of the fuse element between the abutment and the plunger being restricted so that the gasification thereof will be just sufficient to move the plunger promptly and swiftly away from the blowing point to such a distance that the circuit cannot be re-established by the passage of the current through the gas generated, the movement of the plunger being substantially free so as to require the generation of a minimum quantity of gas.

8. A fuse comprising a case, a plunger within said case, an abutment, a fuse element engaged by said plunger and having a blowing point between the abutment and the plunger, the movement of the plunger being substantially free and the explosive effect of the gas generated by the blowing of the fuse being substantially unresisted so that when the fuse blows the plunger with its engaged portion of the fuse element is moved promptly and swiftly away from the blowing point to such a distance that the circuit cannot be re-established by the passage of the current through the gas generated.

9. The fuse of claim 1, the piston and the abutment being face to face with a recess in one of them in which the blowing point of the fuse element lies.

10. A fuse for automatically opening an electric circuit carrying a high tension current and means for automatically displacing the burned ends of the fuse element on the blowing of the latter to such a distance as to prevent the re-establishment of such current, and means for guiding the displaced ends through a considerable distance during such displacement.

11. A fuse comprising a fuse element, a plunger in which the fuse element is partly encased and an abutment separated from the face of the plunger by a slight space through which the fuse element passes, the amount of the fusible metal which will be fused when a blow-out occurs being determined and limited to the portion within said space, so that

the amount of metal to be consumed is regulated by the length of said space.

12. A fuse comprising an open-ended case, a plunger within said case, an abutment, a fuse element engaged by said plunger and having a blowing point between the abutment and the plunger, the plunger being held in position by the fuse element alone so that the gas generated by the blowing of the fuse is confined and, when the fuse blows, the plunger with its engaged portion of the fuse element is moved promptly and swiftly away from the blowing point and out of the open end of the case.

In witness whereof, I have hereunto signed my name.

THOMAS E. MURRAY.