

April 5, 1932.

A. J. BOWIE

1,852,104

ELECTRIC FUSE

Filed Dec. 29, 1923

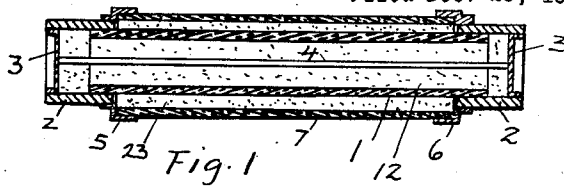


Fig. 1

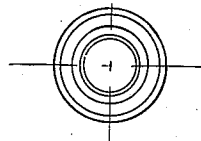


Fig. 2

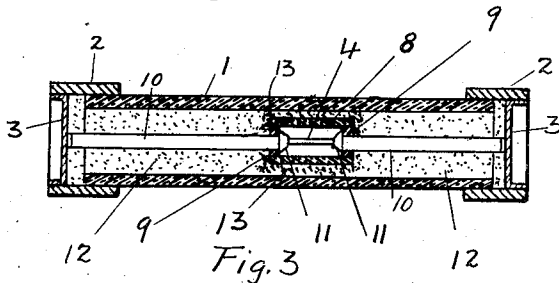


Fig. 3

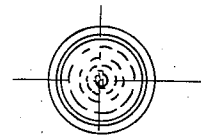


Fig. 4

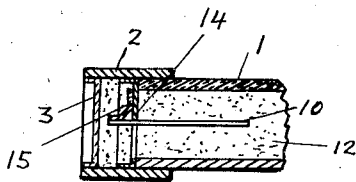


Fig. 5

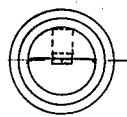


Fig. 6

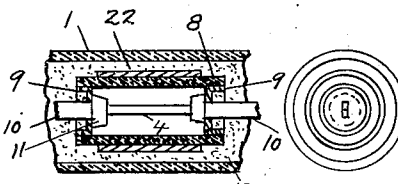


Fig. 9

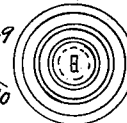


Fig. 10

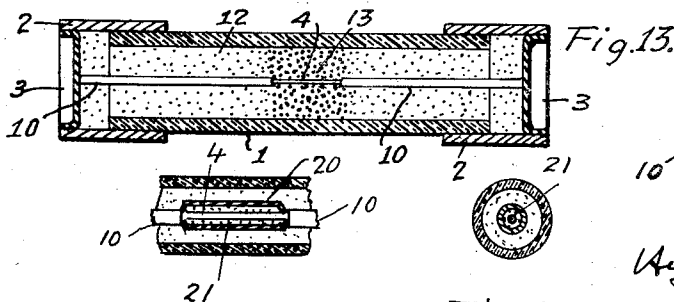


Fig. 13

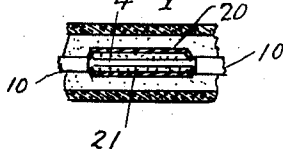


Fig. 7

Fig. 8

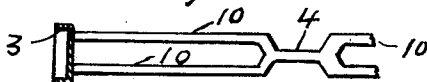


Fig. 12

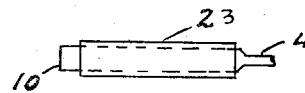


Fig. 11

Augustus Jesse Bowie
INVENTOR.

UNITED STATES PATENT OFFICE

AUGUSTUS JESSE BOWIE, OF SAN FRANCISCO, CALIFORNIA

ELECTRIC FUSE

Application filed December 29, 1923. Serial No. 683,496.

It is the object of this invention to provide improvements in electrical fuses. The principles herein will apply broadly to any class of fuse, but more particularly to high tension fuses.

The particular application is to fuses of the expulsion type wherein the circuit is interrupted by the expulsion of the gases or arc from the container in which the circuit is interrupted.

The fuses in high tension work are generally made in tubular form, either filled or with a non-arcing compound, or left open, the power developed by the heat of the fuse when the circuit is interrupted generating sufficient blow out action to extinguish the arc. The pressures generated are often great under severe short circuits requiring tubes of considerable mechanical strength to withstand the impact and yet rendering material, such as glass or porcelain, inadvisable for this duty, since the heat generated is sufficient to crack such tubes for fuses of large capacity.

To obtain the best results, the fuse tube is hence made of material of sufficient strength to withstand both the blow out and the temporary heat caused by the rupture of the circuit. Materials suitable for tubes of this type, will under some circumstances be defective in surface leakage after long exposure to the weather. To overcome this difficulty box type housings are sometimes provided for fuses of moderate voltages, but for high voltages this is impracticable.

One feature of my invention includes the provision of a double tube of material comprising an inner casing, capable of withstanding shock and an exterior casing of preferably a vitreous material like glass or porcelain integral with the fuse structure. In other words, an interior and exterior tube substantially concentric, constituting a single fuse element having suitable terminals thereon for engaging the clips.

The filled fuse is much superior in blow out action to the open fuse, since the scouring effect of the filler is of great importance in extinguishing the arc. On the other hand, a filled fuse has a radically different thermal condition from the unfilled, the heat being

carried away much more quickly than with the unfilled type, and when fuses are of a larger size limiting problems occur in the heating of the fuse element causing undue heating of the casing. It is one of the objects of this invention to overcome such limitations and to allow the use of fuses of a capacity which would otherwise be prohibitive, and also of materials which could otherwise not be employed. By further extension of the principles of this invention, fuses of any desired capacity may be employed successively.

The interruption of high tension circuits is greatly limited by the capacity of the fuse element. For example, fuses of moderate size work successfully, whereas fuses of larger size, owing to the heat of the fuse element under continuous load will often fail, and it is one of the objects of this invention to overcome these inherent difficulties.

Among the general types of fusible elements are included the lead, zinc tin alloy type of fuse commonly used which melts at a comparatively low temperature, fuses of zinc which melt at a much higher temperature, and fuses of aluminum which melts at a still higher temperature. Except for small capacities, the latter two types are impracticable, if the fuse element is run for any period of time near the blowing point, as the continuous temperature would result in the destruction of the envelope, unless made of porcelain or glass. By means of my invention this difficulty is also overcome.

Figure 1 shows a longitudinal cross section of a fuse with an inner casing enclosing the fuse wire and a concentric outer casing adapted to withstand weather conditions.

Figure 2 shows an end view of the same.

Figure 3 shows a longitudinal section of a fuse with a chamber in the center which may be used for forming an arc.

Figure 4 shows an end view of the same.

Figure 5 shows a partial longitudinal section of a modified fuse of the type shown in Figure 3.

Figure 6 shows an end view of same.

Figure 7 shows a longitudinal section of

a fuse with a central chamber filled with powder or similar material for increasing the blow out action.

Figure 8 shows an end view of the same in section.

Figure 9 shows a longitudinal section of the preferred type of construction of the central fuse chamber shown in Figure 3.

Figure 10 shows an end view of the same.

Figure 11 shows a longitudinal elevation of a fuse link reinforced on the outer ends by metal plated thereon.

Figure 12 shows a longitudinal elevation of a fuse link with bifurcated reinforced ends.

Figure 13 shows a cross section of the fuse tube and fuse with fillers of two different kinds of material with different thermal conductivities.

In Figure 1, "1" is a fuse tube; 2, 2, are ferrules; 3, 3, are pressed-in end caps adapted to be expelled on blowing of the fuse, to which caps the fuse 4, is soldered; 5, is a holder mounted securely on ferrule "2," and "6," is a corresponding holder mounted so that it will slip under pressure on the ferrule "2" on the other end.

As shown in Figs. 1, 3, 5 and 6, the circumferential edges of the caps 3 are sealed by frictional contact against the inside surfaces of the ferrules, thereby normally preventing the escape of gases or air at points between the caps and ferrules.

Holders 5, 6, have rigidly connected therein a weatherproof cylindrical casing "7". The interior space within casing "1" and the space between the casings 1 and 7, are preferably filled with powdered filler of the granular type, marked respectively "12" and "23." The function of the filler around the fuse has previously been described, namely, to provide a better blow out of the arc, and also to insulate the sides of the container, not only from the heat of blowout, but from the normal heating of the fuse.

The space between the tubes 1 and 7, contains filler, "23" to convey the heat generated by the fuse, directly to the air outside, which would not be the case were an air space left between the two tubes. Owing to the difference of expansion of tubes 1 and 7, which are made of different materials, the joint between 6 and 2, is a slip type which will prevent undue temperature stresses. This joint, however, is tight under atmospheric conditions and excludes dirt and moisture.

The material of casing 1, is strong, and preferably non-absorbive of water and a good insulator such as bakelite, whereas the casing 7, is of material like porcelain or glass, providing a permanent surface, not affected by weather conditions.

While, as heretofore mentioned, box type housings have been provided in which the

fuses are housed for voltages of moderate value, the construction herein is novel, in that the housings and fuses are combined in the single element giving a combination of the high breakage strength, freedom from instantaneous heat and good exterior surface leakage conditions.

In Figure 3, "8" is a cylindrical arcing chamber provided with end plugs 9, 9, which preferably fit snugly in same and yet allow ready expulsion under pressure within the chamber. 10, 10, are electrical connections, preferably soldered to the fuse element 4, which is of relatively short length. 11, 11, are the joints between connections 10, 10 and fuse 4, and may be made of solder or other material; the connections 10, 10, are soldered directly to the end caps 3, 3, from which contact is made to the metallic ferrules 2, 2, adapted to be inserted in suitable clips. The chamber 8, is preferably left unfilled for fuses of large capacity, and the balance of the tube is preferably filled with the granular filler, 12, 12. Around chamber 8, is the filler 13, made of different material from filler 12, 12.

There are two points to be considered in fuse design, first the condition obtaining under heavy loads not sufficient to blow the fuse, wherein the fuse element will necessarily heat, part of it approaching the melting point of the material, and second, the condition affecting the blowing of the fuse.

In large fuses the amount of heat which may be generated in the fuse element is so great that a fuse tube of large and often impractical size must be provided to carry off safely the heat of the fuse without danger of destruction of the tube. This is particularly the case with the filled tube for high voltages where the heat must be disposed of thru the walls of the tube and cannot be taken thru the end ferrules, owing to the length of the fuse tube. To overcome this difficulty I made the connections 10, 10, of very much larger electrical capacity than the fuse 4, so that the heat generated by these connections is well within the capacity of the tube. If the fuse 4, however, in Figure 3 had no inner casing 8, and were surrounded with filler 12, the heat generated thereby would be liable to damage the adjacent tube, unless special precautions are taken.

The first requirement then of a fuse, without resorting to an excessive amount of metal which would be objectionable, is that the smallest possible amount of heat should be generated in 10, 10, and that the heat in fuse 4, should be protected from damaging the walls of the tube 1. It is desirable to dissipate thru the walls of the tube as rapidly as possible, the heat from connections 10, 10. This I accomplish by the use of a granular filler 12, of high thermal conductivity, at the same time around the central portion of

the fuse, I use a filler 13, of low thermal conductivity, preventing the heat from fuse 4, affecting the walls of the tube and forcing the heat generated therein to dissipate itself by traveling along the connections 10, 10.

To effect the corresponding result, from this standpoint only, the chamber 8, with ends 9, 9, may be omitted entirely, the central portion of the tube being filled with the granular filler 13, of low thermal conductivity, which is hence directly in contact with the fuse element 4, or else the granular filler 13, may be made of the same material as the balance of the filler 12, the thermal insulation of element 4, being obtained thru the chamber 8. In either event the invention in this phase lies in the provision of different thermal insulation between the fuse element 4, and the tube 1, than obtains between the connections 10, 10, and the tube 1.

The connections 10, 10, may be of the same material as the fuse 4, a larger section giving the increased conductivity, but it is preferable to make them of a different material and this is a novel feature in fuse construction. Connections 10, 10, may be of such nature as would be consumed by the current, in the event of a very high current, but the preferable form of operation is the expulsion thereof from the ends of the tube. When the fuse 4, blows heat will be generated in the center therefrom, and when this is broken it will volatilize the material therein and cause sufficient pressure to expel the caps 3, 3, and connections 10, 10, from opposite ends of the tube, the expulsion extinguishing the arc and opening the circuit, since the end caps 3, 3, are designed for such purpose, namely, to provide both a safety valve and to allow a sufficient pressure to extinguish the arc when the fuse operates.

The extinguishing of the arc depends upon the rapidity of action, and hence for this reason it is desirable to make the connections 10, 10, as light as possible. Also it is desirable to make them as high a conductor of heat as possible, in order to dissipate the normal heat from the fuse element 4. For this reason I preferably made connections 10, 10, of copper, which is made especially flexible, since copper is a very high conductor of both electricity and heat.

The construction in Figures 1 and 3, shows the fuse soldered to the end caps 3, 3. However, this is not necessary since any other means of connection may be given, as shown in Figure 5, wherein the fuses are fastened to contact cap 14 preferably thru strip 15, made of low melting material. Where lead or zinc type of fuse is used, in larger capacities in a filled chamber, there is a tendency for the fuse to remain as a column of liquid and to conduct current in this condition, hence generating an undue amount of heat. This difficulty I overcome thru the arcing

chamber 8, which being unfilled also allows the fuse to pull apart and start an arc, and the arc generating heat with extreme rapidity causes instantaneous action.

It is desirable to have a limited amount of air in the arcing chamber to aid in the blow out of the fuse ends. In the construction in Figure 3, the arcing chamber 8, may be made of strong, preferably fireproof rigid material such as ebony asbestos which will prevent the extreme instantaneous pressure coming on the tube 1, which may be of porcelain, and which will also insulate this tube from the extreme heat generated. In this event the construction in Figure 3, is in effect a modification of the principle shown in Figure 1, namely, a combination of two tubes, the inner tube however, not extending the full length.

In the construction shown in Figure 5, advantage is taken of the fact that the lead type of fuse and the connection 15 if made of similar material and of approximately the same area will melt at the same time from short circuits. The result of this will be that under normal conditions the heat from connection 15, will be carried away by connections 10, 10, and ferrules 2, 2, but in event of a short circuit, the connections 15, and fuse 4, would melt at approximately the same time, 15 remaining as a liquid, whereas 4 would open the circuit and generate an arc, allowing the ready expulsion of connections 10, 10, without the blowing out of contact cap 14.

The principle of operation of fuses by means of a direct arcing chamber is of value, in the prompt action of the fuse. The gas generated for the expulsion is derived from the volatilization of the fuse link 4. Where the other material therein is insufficient to give the desired action, it may be reinforced by the use of buttons 11, 11, of solder or corresponding material of sufficient size to generate the desired amount of gas. The advantages are obvious in that it is preferable to volatilize material which melts at a low temperature rather than one which melts at a higher temperature, such as are connections 10, 10, which are preferably made of copper.

To increase the blow out action of the fuse, the construction shown in Figure 7 may be used, 20 being an envelope similar to the casing 8, and 21, being the filling material, which may partially or completely fill the casing, consisting, for example, of gunpowder, which will safely stand the temperatures of low melting fuses, but will be ignited by blowing of the fuse and will generate sufficient gas to expel the end caps and connections.

Where fuses of large capacity are employed, the resulting pressure from blowing the fuse within chamber 8, is liable to be very high, due to the great heat suddenly generated. To overcome this difficulty Figures

9 and 10 show the preferred type of construction wherein the casing 8, is of insulating material such as mica, which will stand high momentary temperatures. This is reinforced by a casing 22, of high strength material which may consist of metal. The end plugs 9, 9, for closing this casing may be made as shown in cup form of material such as pressed lead, which will be readily expelled under pressure.

For fuses as at present constructed, when blown under light loads, or where the fuse wire is light the fuse itself often disintegrates without blowing out the end caps, thus leaving no indication that the circuit has been opened. The use in a fuse tube of powder or corresponding material readily volatilized on blowing of the fuse which will act with certainty and blow out the end caps, thus serves the doubly useful purpose of providing a definite indication at a glance that the fuse has blown, as well as extinguishing the resulting arc.

The term fuse, as is commonly applied to apparatus of this nature constitutes an integral fuse element comprising the fuse link, holder for same and suitable terminals therefor, and in the claims, the term is used with this understanding and does not mean fuse links alone.

In the construction of the fuse element the material used in link 4, may be extended to the end cap connections, the conductors 10, 10, being reinforced by either a larger section of the same material or by the addition of a reinforcing piece of another material connected thereto and running from the ends of 4, to or nearly to the end caps or corresponding connection 3. An excellent type of reinforcement consists of plating the end connections 10, of the main fuse by such material as copper, to provide the necessary reinforcing.

Figure 11 shows the fuse element only, with plating 23 on the connection 10.

Figure 12 shows an alternative type of reinforcement, 10 consisting of two branches for each half, affording a large radiating surface for the heat. When the fuse blows, especially if of the zinc tin type, if the end cap does not blow off instantly the connection of the branches will melt and carry current, which will automatically follow one of the branches, which it will promptly melt off and blow.

If desired, wires 10, 10 may be made stiff, causing the blow out in the center to give direct pressure thereto on the end caps.

The filled fuse has an advantage over the unfilled in that the entrained air is very much less requiring a correspondingly smaller amount of heated vapor to cause proper expulsion. A limited quantity of air in casing 8 is of advantage in forming the necessary blow out pressure reserve capacity for

putting out the arc. A very suddenly applied pressure in the central part of the tube, as in Fig. 3, particularly with the fuse tube filled with a granular filler, is apt to blow up the tube before it has time to expel the end caps 3. If conductors 10—10 are rigid, the internal pressure acting thereon will be transmitted by direct compression thereon to the end caps, which will be mechanically expelled without damaging the tube.

What I claim is:

1. A fuse comprising a fuse link, terminal connections for same, an inner imperforate casing composed of material of high strength, in combination with an outer imperforate casing composed of material of high resistance to surface leakage, and granular filling material between said inner and outer casings.

2. A fuse comprising a fuse link, terminal connections for said fuse, an inner imperforate casing composed of material of high strength, in combination with an outer imperforate casing comprising a vitreous material, and granular filling material between said inner and outer casings.

3. A fuse comprising a casing normally closed to the atmosphere, terminal connections for said fuse, a fuse link within said casing, conductors within said casing connecting said fuse link and said terminal connections, thermal insulating means between said fuse link and said casing, said conductors and said thermal insulating means being adapted to be ejected from said casing upon the blowing of said fuse.

4. A fuse comprising a casing normally closed to the atmosphere, terminal connections for said fuse, a fuse link within said casing, electrical connections between said fuse link and said terminal connections, said electrical connections being adapted to be ejected from said casing on the blowing of said fuse, a filling material of relatively low thermal conductivity between said electrical connections and said casing, in combination with thermal insulating means between said fuse link and said casing of higher thermal insulation than that of said filling material.

5. A fuse comprising a casing normally closed to the atmosphere, terminal connections for said fuse, a fuse link within said casing, rigid electrical connections between said fuse link and said terminal connections, and vent means for opening said casing to the atmosphere thru pressure generated by the blowing of said fuse and transmitted directly by said rigid electrical connections to said vent means, thereby opening said fuse to the atmosphere.

6. A fuse comprising an outer casing normally closed to the atmosphere, terminal connections for said fuse, a fuse link, insulating filling material for said casing, an inner casing surrounding said fuse link, and means for excluding therefrom said filling material, in

combination with means operated by the blowing of said fuse for opening said casing to the atmosphere.

7. A fuse comprising an outer casing normally closed to the atmosphere, terminal connections for said fuse, a fuse link, an inner casing surrounding said fuse link, electrical connections between said fuse link and said terminal connections, insulating filling material surrounding said electrical connections, closing members for said inner casing adapted to exclude therefrom said filling material, in combination with means operated by the blowing of said fuse for opening said casing to the atmosphere.

8. A fuse comprising an outer casing normally closed to the atmosphere, terminal connections for said fuse, a fuse link, insulating filling material for said outer casing, an inner casing surrounding said fuse link and excluding therefrom said filling material, in combination with end members for closing said inner casing and means actuated by the blowing of said fuse for ejecting said end members and also for opening said outer casing to the atmosphere.

9. A fuse comprising an outer casing normally closed to the atmosphere, terminal connections for said fuse, a fuse link within said casing, electrical connections between said fuse link and said terminal connections, an inner casing surrounding said fuse link, filling insulating material surrounding said electrical connections, means for excluding said filling material from said inner casing, and means actuated by the blowing of said fuse for ejecting said electrical connections from said outer casing.

10. A fuse comprising a fuse link, terminal connections for same, an inner casing of arc resisting material, in combination with an outer imperforate casing of material of high resistance to surface leakage, and filling insulating material between said inner and outer casings adapted to transmit the normal heat of the fuse to the atmosphere.

11. A fuse comprising a fuse link, a tubular casing enclosing said fuse link, terminal connections for said fuse link, end caps on the ends of said tubular casing, said end caps being adapted to normally seal the ends of the casing to maintain a certain gas pressure within the casing, and conductors in the casing between the fuse link and the caps, which said conductors are adapted to be ejected from the casing upon the blowing of the fuse link.

12. A fuse comprising a fuse link, a tubular casing enclosing said fuse link, terminal connections for said fuse link, imperforate caps for sealing the ends of the tubular casing, the said caps being frictionally sealed against the ends of the casing so as to normally prevent air from passing through the ends of the casing, said caps being adapted to be blown from the tube by pressure gener-

ated in the tube upon the blowing of the fuse link, and conductors within said casing between the said fuse link and the caps, the said conductors being adapted to be ejected from the casing by the pressure generated upon the blowing of the fuse link.

13. A fuse comprising a fuse link, a tubular casing enclosing said fuse link, terminal connections for said fuse link, imperforate caps in the ends of the casing, the said caps being normally maintained in the ends of the casing by their frictional engagement with the walls of the casing, and adapted to normally seal the ends of the tube, the said caps also being adapted to be ejected from the tube by a pressure generated in the said tube by the blowing of the fuse link, and conductors within the casing connecting the caps with the fuse link, the said conductors being adapted to be ejected from the tube by the pressure ejecting the caps.

In testimony whereof, I affix my signature.
AUGUSTUS JESSE BOWIE.

70

75

80

85

90

95

100

105

110

115

120

125

130